APPENDICES

- 1. Feedstock Description Report, Task A1
- 2. Trip Reports
- 3. Cellulase Enzyme Dosage Study
- 4. Process Flow Diagrams
- 5. Equipment List
- 6. Waste Water Report
- 7. Proforma and Sensitivity Analysis

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York Ethanol Facility

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February 1, 2000

To: Fran Ferraro, Merrick & Company

cc: Greg Heuer, Chris Standlee

Report, Task A1, Feedstock Description

Project No. 19013442 Building a Bridge to the Corn Ethanol Industry

This report summarizes the results of research conducted to 1) determine the availability of corn stover, and 2) evaluate the spent distiller's grains (DDG), for conversion to ethanol at High Plains Corporation's York, Nebraska Ethanol Facility. References are cited where appropriate.

CORN STOVER

From consultation and literature available, the best economic area of collection was assumed to be within close proximity to the plant operations. For practical application, including primarily ease-of-access to major highways (Highways 81 and 34 and Interstate 80), this report covers a five-county area centered around York County. The Ethanol Facility is located on Highway 34 approximately 3 miles east of the interchange with Highway 81 and 7 miles north of Interstate 80. This area includes irregular boundaries, but will represent an approximately 70-mile maximum transportation route from field to collection warehouse to plant site.

In all cases, the most conservative data or estimates were used. The following table summarizes the tons of stover that could reasonably be collected, stored, processed and transported to the York facility. The 1997 – 1998 *Nebraska Agricultural Statistics* report¹ on "Corn For Grain" acres harvested for the crop years 1995, 1996, and 1997, revealed that 1995 resulted in the lowest acres (and yield). The University of

Nebraska has reported² on collectible corn residue for 25 counties including the 5 counties of interest in this report. Their data included low, high, and "best estimates", and provided for exclusion of Soil Conservation Acres. This report used the lowest reported data less the tons of Soil Conservation residue.

High Plains Corporation (HIPC) has received privileged information indicating that 60% removal of stover from fields is both economically and practically viable using a proprietary system of custom harvesting, baling, storage and transportation³. Assuming that 50% of those producers with stover available will contract to participate in a collection process, then 30% of the collectible stover would be available for conversion. It has been variously reported that up to 3.7 tons per acre of stover is available³. Ranges of reporting could result from the inclusion or exclusion or the cobs and shucks with the stalks (lowa State University has reported⁴ that cobs and shucks make up 1.0 tons per acre). The table also indicates the resulting tons of stover if 30% of the available corn-growing acreage participated and 2.0 tons per acre can be harvested (a randomly selected, conservative number that approximates a value provided by the proprietary custom harvester noted above). This comparison provides a range that may be used when evaluating conversion options and equipment requirements for the facility.

County	Corn Acres Harvested	Collectible Stover	30% Acreage	30% of
	1995 Crop Year	1993 Residue	Participation @	Collectible
	Bushels	Tons	2.0 Tons/Acre	Stover, Tons
York	242,000	249,000	145,200	104,700
Hamilton	250,400	305,000	150,240	91,500
Seward	125,100	86,000	75,060	25,800
Fillmore	180,800	186,000	108,480	55,800
Polk	150,800	137,000	90,480	41,100

Total Tons for Biomass Conversion

569,460

to

318,900

STOVER COLLECTION AND COSTS

Proprietary data³ provided to High Plains Corporation indicates that this volume of stover can be harvested, baled, and transported to collection centers within 120 days of harvest at a delivered price of less than \$35.00 per ton. Initial foray into this new feedstock at this volume will likely prove more costly until the collection centers and infrastructure are established.

DGS

The York facility uses approximately 13,800,000 bushels annually of grain to produce 36,000,000 gallons of anhydrous ethanol. The Distiller's Grains and Solubles (DGS) by-product will contain both insoluble portions of the spent grain combined with a portion of the soluble portions. The total plant output of soluble and insoluble solids (dry matter basis) is approximately 350 tons per day (124,250 annual tons). Testing analysis⁵ indicates that 9% of this product is fermentable (enzyme soluble carbohydrate) and another 9% is fiber⁶ that may be converted using cellulase technology. This equates to 63 tons per day of fermentable feedstock. Conversion of this 18% portion of the DGS to ethanol would also raise the protein level, which may add value to the remaining by-product. Conversely, addition of unconverted starches from the stover process along with the residual lignin and ash to the DDGS will significantly reduce the protein value.

CONVERSION - PLANT SIZE EVALUATION

Proponents³ of various conversion technologies have professed to achieve up to 80% conversion of cellulose and hemi-cellulose to glucose, which equates to 135 gallons of ethanol per ton of biomass. Others have stated 75 gallons of ethanol per ton as a realistic goal. NREL has reported⁷ that Corn Stover is 41% cellulose and 21% hemi-cellulose. If the conversion technology results in comparable corn/milo conversion, and the known corn/milo yield is 80 gallons of ethanol per dry ton of grain with 68% fermentable starches (2.6 gallons per bushel) then a ratio can be established to calculate theoretical stover yield. This relationship is shown in the following table.

For project evaluation, it is recommended that the conservative figure (or the average of the two assumptions) be used.

- 62 % "fermentables" in corn stover
- 68 % fermentables in corn/milo (starch, DMB)
- 80 gallons/ dry ton of corn/milo yield
- 64 gallon/ton assuming corn stover conversion is 80% of starch

$$\frac{62}{68} = \frac{X}{86}$$

X = 73 gallons/ton assuming conversion is equal

68 Gallons/ ton average of assumptions

Using this yield and the stover available from this research then 21,685,200 gallons can be produced from stover and 1,520,820 gallons from DDGS of anhydrous alcohol production.

References Cited

- ¹ NEBRASKA AGRICULTURAL STATISTICS, 1997 1998, Nebraska Dept. of Agriculture, Issued November 1998
- ² Feasibility of Corn Residue Collection in Kearney, Nebraska Area, Report of Findings for Western Regional Biomass Energy Program by University of Nebraska-Lincoln, Industrial Agricultural Products Center, September 1993.
- ³ Summary notes of proprietary discussions with confidential business associate(s) by HIPC Plant Manager, D. Allison, 1998 1999.
- ⁴ Report on Agricultural Residue Harvest and Collection, prepared for Western Regional Biomass Energy Program Western Area Power Administration by North Dakota State University, November 1994.
- ⁵ Enzyme Development Corporation analysis report to Greg Heuer, HIPC Director of Plant Operations, October 19, 1998.
- ⁶ Servi-Tech Laboratories Feed Analysis Report to HIPC, typical.
- ⁷ NREL Memo, "Results of analytical analysis on fiber samples" to Danny Allison, HIPC from Kelly Ibsen, NREL, July 21 1998.



MERRICK & COMPANY

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TRIP REPORT

DATE:

April 1 and 2, 1999

PROJECT:

Building a Bridge to the Corn Ethanol Industry

PROJ. NO.:

19013442

LOCATION:

Iron Horse Custom Farming, Harlan, Iowa

High Plains Corp. Ethanol Plant - York, Nebraska

ATTENDEES:

Danny Allison

High Plains Corp.

Joe Casey

High Plains Corp.

Dale Bender

High Plains Corp.

Tom Schechinger

Iron Horse Custom Farming, LLC

Dick Voiles

Merrick & Company

Visit to Iron Horse Custom Farming in Harlan, Iowa:

1. The corn stover harvest, last fall, was cancelled by Great Lakes Chemical at just under 50% completion. Great Lakes could not sell their products.

- 2. Because the stover demand has fallen from a forecast of 65,000 tons/year to about 30,000 tons/year, Iron Horse is selling some of their equipment. A high speed tractor in good conditions is valued at approximately \$60,000 to \$65,000...
- 3. Great Lakes produces furfural, furfural alcohol, and Furfafill (a by-product used as a glue extender in fiber board) at their Omaha plant.
- 4. Great Lakes burns about 50% of the Furfafill by-product for energy. For each 20 tons of stover a ton of ash is produced. This ash was originally sent to landfill but now most is applied to local fields.
- 5. Iron Horse was successful in changing Iowa law to allow custom hauling using the high speed tractors. These tractors have air ride, air brakes and other safety features. They are more stable and much easier to control than conventional tractors. These tractors are superior to trucks in collecting corn stover because they are better able to work in snowy, wet or heavily frosted fields. They are more economical than trucks within about 40 miles of the delivery point. The advantage for farm tractor/trailers averages \$1.49/ton of stover within the 40 mile haul distance.
- 6. Many factors influence the collection of corn stover. Farms near river bottoms would like to remove essentially all of the stover. However, conventional methods allow a pick up of 60 to 70 % before the amount of dirt inadvertently picked up becomes excessive. Fields on hill sides generally yield less stover and leave much of it on the

- field to prevent erosion. Approximately 40% of the stover must be collected to make the operation economically attractive.
- 7. Collected corn stover is put into bales by multiple, independent baling contractors. Although there are numerous baling contractors, experience has shown that only about 30% of these are reliable and have the skill to make good, dense bales that will transport economically and store well.
- 8. If bales are not dense the transportation costs become uneconomical. Large round bales should be about 1200 pounds dry weight. Skill in making the bales can vary this weight by as much as 600 pounds.
- 9. Large round bales wrapped in plastic netting for transportation and storage have advantages over twine wrapped bales. Bales held by either sisal or plastic twine do not store well and allow losses from the bale at highway speeds.
- 10. Setting up a collection program is time consuming. Farmers need to understand the benefits for their individual farms and be convinced to try stover collection. Each set back (such as cancelled harvest) undermines the trust that must be established. There are often several benefits for a farmer besides the actual price paid for the stover such as being able to get into the field earlier in the spring, saving on disking operations, offsetting some increase in fertilizer cost by savings in the soil nitrogen addition requirements.
- 11. Additional benefits will happen once the program is shown to be successful. For example, there are hybrids that produce the same corn yield but have more foliage leading to more stover. These may become attractive to farmers who don't want them now.
- 12. To do a harvest effectively in the short time window available means that one must be over-equipped. Practical use of the equipment will require the harvesting of other materials not having the same schedule. This should be part of the overall plan. For example, switch grass could be harvested after the corn stover harvest is complete.
- 13. Farmers would be more comfortable if they had more than a single buyer for their product.

Visit to the Harlan terminal of Great Lakes Chemicals:

- 1. The terminal had approximately 40,000 bales stored on 8 to 10 acres surrounding a processing building. Of the 40,000 bales, 22,000 were from the most recent harvest. Bales are stored in rows, stacked three bales high. Dense bales, wrapped in plastic netting were storing well. Some of the bales were from the previous year's harvest (that is, they have been in storage since the fall of 1997). Low density bales and bales wrapped in twine were falling apart and could not be moved as a bale.
- 2. The processing center chops the raw stover and extrudes it into about 1-1/2" diameter by 4 to 6 inch long pellets or bricks. These are conveyed into large trucks for transport to the Great Lakes' Omaha plant. They have experimented with the extruder and found that they can vary the density of the pellets to meet plant requirements.

3. Examples of the several products which could be manufactured solely or partly from corn stover were available. Included were fiberboard, animal bedding, seeding mulch, furfural etc.

York Ethanol Plant:

- 1. Toured the plant with the potential addition of a corn stover/spent distillers grain (SDG) addition foremost in mind.
- 2. The beer column can handle nearly twice the current load thus potentially eliminating the need to duplicate for new throughput.
- 3. A single boiler can easily handle the average steam requirement. However both boilers are run continuously in a turned-down mode in case one should fail. If a new plant did not add a third boiler this standby or spare capability would be lost.
- 4. The air compressor may be adequate to handle a second plant.
- 5. Chilled water systems may be adequate for a second plant.
- 6. When able High Plains sells wet spent distillers grain cake to local feed lots thus saving the cost of drying. If SDG must be transported a significant distance, it is necessary to dry it.
- 7. Dry SDG can be loaded into rail cars using a horizontal auger that evenly loads the car. Trucks are loaded with a front loader.
- 8. A set of P&IDs, block flow diagram and descriptive information were given to Merrick for project use.
- 9. The high quality ethanol distillation section was shut down due to lack of product demand. This situation is not likely to continue.
- 10. There appears to be ample space for plant additions either as a separate plant or as an integrated plant. Feed stock storage must be separately evaluated.
- 11. High Plains has targeted the week of April 5, 1999 to supply a draft report to the project for their parts of the corn stover project. Some of the most important aspects are:
 - Assumed available corn stover is 30% of the produced corn stover in York County and the two adjacent counties. This is roughly equivalent to a 70 mile radius. It means that 400,000 to 500,000 tons per year of stover is available.
 - Placing a value on delivered stover is not easily done. One approach would be to back into the highest cost stover could be for the operation to be economically attractive.
 - Based on 77 gallons of ethanol production from each ton of corn stover, the plant capacity will be roughly 36 million gallons per year. Published ethanol yields from corn stover vary from 75 to 135 gallons/ton. The value of 77 was selected to match an NREL paper that equated corn stover yield to 62% of corn grain yield.
- 12. NREL (Kelly Ibsen) has a consistent set of utility prices for the York plant, which she is using in developing an ASPEN PlusTM model. These utility prices should be used for this project.
- 13. York recently added a RO unit on boiler feed water, in which, will reduce the cost for this commodity. RO is due to high silica in the feed water.

- 14. Plant raw water is from three wells located on-site.
- 15. SDG is produced at the rate of 300 tons/day.
- 16. Some important questions which we must address during the course of this project are:
 - SDG is sold for \$100 per dry ton as animal feed. Is this not too high a value for ethanol feed?
 - If SDG is fed to the ethanol plant presumably the volume of solids would be reduced as cellulase breaks down much of the fiber. However, there may be no effect on the proteins which are the basis of the live stock feed price. It may be that the value per ton as animal feed will increase if SDG is processed without stover?
 - There is a belief that the corn plant and the stover plant cannot merge until after distillation. Is there a basis for this?
 - The 300 tons per day of SDG yields 2 million gallons of ethanol per year. Does this small yield justify the cost of investigation in this study?
 - An alternative to increasing the overall ethanol production at York is to blend stover into the existing plant feedstock by backing out corn grain and observing the economic effects.

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MERRICK & COMPANY

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TRIP REPORT

DATE:

November 3, 1999

PROJECT:

Building a Bridge to the Corn Ethanol Industry

PROJ. NO.:

19013442

LOCATION:

High Plains Corp. Ethanol Plant - York, Nebraska

ATTENDEES:

Brian Pasbrig

High Plains Corp.

James Atmore

High Plains Corp. High Plains Corp.

Dale Bender Dick Voiles

Merrick & Company

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On November 3rd, 1999 I traveled to York, Nebraska to visit the High Plains grain to ethanol production facility. The purpose of this visit was to discuss the potential placement of equipment in a new corn stover facility that would be built and operated at the same location.

The following is a compilation of notes taken during the visit.

Met Dale Bender (operations manager). Mr. Bender set up a meeting with Brian Pasbrig and James Atmore to discuss the various questions with me.

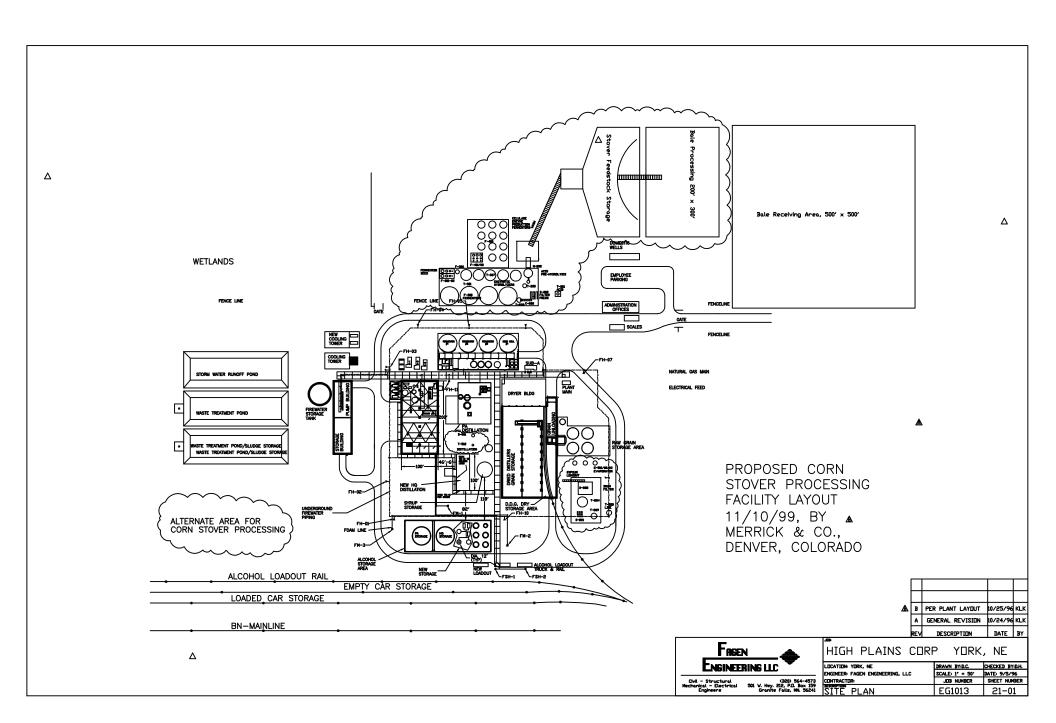
I expalined that my initial layout located the new facilities North of the administration offices in the cropland owned by High Plains.

• The bale receiving area (500 ft. x 500 ft.) would be located adjacent to the N/S road to the east. – The bale receiving area should have a separate access entrance with separate weigh in/out scales due to the current truck traffic entering the plant. Discussed having a separate access road from highway 34 for the bale receiving area and believe that this is possible, however the county would be less likely to approve an exit from highway 34 due to the number of trucks anticipated.

- The stover feedstock storage area was discussed. —The loader for this area should be included in the capital cost estimate as sharing a loader with the existing facility would be impractical due to the usage.
- Discussed the hydrolysis/fermentation building location and layout. Location N. of the current fermentation building looks good. The building layout should be mirror image to the existing building with respect to tanks. Areas should be designated for control room, QC Lab, operator lab, and offices. Integration with the existing DCS system will need to be incorporated into the project, and possibly a central control room for both plants will need to be installed. The existing ammonia tank can be shared. The sulfuric acid tank should be added for a new facility. These tanks are presently loaded by truck.. The loading facilities can be used and transferred to the new facilities. The fermentor seed tanks should be located near the fermentors. The celulase enzyme production systems should be located in a separate building to the north.
- The material handling systems were discussed along with a new rail spur for lignin loadout and lime handling.
 - The current DDG rail spur (running N/S) might be extended north to allow use for lignin loadout, however the amount of rail traffic anticipated and rail car staging would likely interfere with the current truck traffic for grain unloading. This option could be studied further but at present does not appear to be feasable. A new rail spur to the ease of the DDG Loadout may be more practical.
 - Locating the evaporator and centrifuge area near the existing E/W rail spurs and pumping the slurry across the existing facility was also discussed. The lignin handling area could then be located east of the existing DDG facility and could use the DDG loadout spur (or supplement the spur) with minimum impact on the existing truck traffic.
 - The existing centrifuge building has spare locations for additional centrifuges. Locating the lignin centrifuges in this building would save significant capital costs due to the building costs being eliminated.
 - The lignin area should have a surge pit for conveyor upsets.

Interoffice Memo

- The existing distillation area and mol sieve could be expanded to allow processing of the new stream. In particular if a preliminary separation was made (to say 160 proof) then the existing facility could probably handle the final refining. The movement of slurry across the plant becomes more attractive if the existing distillation facilities can be expanded to handle the extra capacity.
- The gypsum and lime handling would then be located near the lignin loadout area.
- Plant walkdown also revealed an area used for equipment laydown that could be used. An alternate layout will be produced that shows the new facility in the SW corner of the plane with access from the west (road one mile west). This option would allow minimal impact to the existing operation.
- The existing electrical capacity of the plant was discussed with Mike Kriewald. The line capacity to the substation should be adequate for the new facility, however a new 34.5 KV to 480 V transformer would be required for the new plant.



Cellulase Enzyme Dosage Study Jim Linden 28. July 1999

I have reviewed literature published during the past ten years that describes the effects of cellulase enzyme dosage on extend and time dependence of hydrolysis of pretreated lignocellulose. The data has been collected with the purpose providing a recommendation regarding over-capacity of enzyme production for the Separate Hydrolysis and Fermentation (SHF) process under consideration. Ten relevant papers were found; the important facts from each will be reviewed in order of chronological appearance.

Comparisons of enzyme dosage and *Trichoderma* enzyme manufacturer with the hydrolysis of pretreated aspen wood was presented by Schwald et al. in 2 to 60 L reaction vessels (1). Over 85% of the cellulose could be hydrolyzed to glucose in 96 hours when an 8% substrate concentration was used with 9 FPU/g substrate. The same average conversion appeared to be complete in 48 hours when 17 FPU/g substrate was used. A visual estimation can be made from the attached figure (schwfig1).

Two related papers by Spindler, Wyman and Grohmann from NREL appeared in 1990 that described Simultaneous Saccharification and Fermentation (SSF) of dilute sulfuric acid pretreated herbaceous crops, which included corn stover (2, 3). Little difference was found in final yield between the low and high cellulase enzyme loadings. In all cases, SSFs showed faster and higher conversion than SHFs for the same enzyme loadings. For instance, comparison of 13 and 26 IU/g cellulose loadings with beta-glucosidase supplementation, corn stover SSF theoretical yields after seven days were 86 and 92 percent, respectively. Table 1 from reference 2 is duplicated as an attachment (spintab1).

A 1994 paper by Penner and Liaw provided some kinetic modeling for the *Trichoderma* cellulase system (4). Under conditions of substrate inhibition using high ratios of substrate to enzyme, the relative enzyme hydrolysis rate varied only 30 micromol/h over the range from 10 to 100 FPU / g microcrystalline cellulose substrate.

A paper in 1996 contained exactly the kind of information desired (5). The effect of enzyme loading on ethanol production in batch SSF of pretreated sugar cane bagasse using 7, 15 and 30 FPU / g cellulose was given in Figure 2, which is attached (lynnfig2). Ethanol production plateaus after 50 hours using 30 FPU / g. Treatment with 15 FPU / g had produced approximately 80% that of former case in 50 hours and 100% that of the former case in 300 hours. These data indicated an advantage of using the greater loading in SSF. Presumably similar results would be obtained in SHF. However, when examining the conversion based on cellulose concentration, the decline in final substrate utilization with declining enzyme loading was small. The effect was thought possibly to be pretreatment dependent, rather than a substrate-

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specific effect that might result from reduced inactivation of enzyme owing to the low lignin content of the pretreated material.

An alkaline pretreatment of corn stover was studied in a 1998 paper by Belkacemi et al. (6). Saccharification of the pretreated material was followed by fermentation, hence SHF. Indeed 55-70% of the cellulose was hydrolyzed after 48 hours, and the extent of hydrolysis was dependent not only on cellulase units, but also more dramatically on the amount of beta-glucosidase added to the system. This finding supports data of Spindler et al. (2, 3) that is presented above. Increasing the solids loading to 10% (w/v) during hydrolysis from 5% almost reduced the saccharification by half.

Baker et al. from NREL continued studies on enzyme mixtures using purified enzymes in a 1998 paper (7). Results revealed that at least one synthetic mixture utilizing enzymes from three different organisms delivers performance competitive with that of a "native" *T. reesei* system.

In conclusion, increasing the enzyme dosage by a factor of two appears to reduce the time to similar extent of conversion by from 10% (2) to50% (1) to 75% (5). The range encompasses different substrates and different enzyme systems. Certainly, using an enzyme system with sufficient beta-glucosidase reduces the advantage. Also, using easily convertable substrates, such as corn stover, reduces the advantage. Knowing that the cost of enzyme production contributes very significantly to the product value, I would find it prudent to use 15 FPU/g cellulose for SHF, especially since the enzyme produced on pretreated corn stover should have superior characteristics for hydrolysis of the same substrate (8).

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- 2. Spindler, D. et al. 1990. Ethanol Production by Simultaneous Saccharification and Fermentation (SSF) of Pretreated Corn Cobs and Corn Stover. Proceedings of Corn Utilization Conference III, St. Louis, MO, June 19-21.
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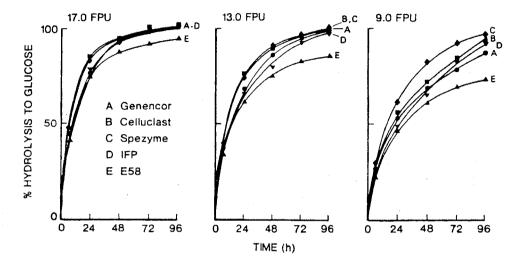


Fig. 1. Effect of enzyme concentration (FPU/g substrate) on enzymatic hydrolysis of pretreated aspen wood using various enzyme preparations supplemented with β -glucosidase (Novozym) to a constant level of cellobiase activity.

Tab. 1. SSF - Final (7 day) percent theoretical yields for S. cerevisiae and mixed culture at selected cellulase enzyme loadings with and without β-glucosidase supplementation on dilute acid pretreated corn residue crops at 37°C.

	/				S. cerevisiae	·		
IU β-glucosidase: IU Cellulos	e		0:1	¥ ;		/	8:1	
IU Cellulase/g Cellulose	7	13	19	26	7	13	19	26
Corn Cob Corn Stover	58 54	63 59	80 77	87 84	87 82	91 86	94 90	94 92
					*Mixed Culture			
Corn Cob Corn Stover	76 75	85 84	89 87	92 89	92 86	93 89	96 92	96 92
SAC - Fin cellula	al (7 day) s se enzyme	accharifica loadings wi	tion yield ith and wi	s for acid p thout β-glu	retreated corn cob and stov cosidase supplementation a	er at select t 45°C.**	ted	
IU Cellulase/gm Cellulose	7	13	19	26	7	13	19	26
Corn Cob Corn Stover	55 48	64 64	78 77	86 84	69 64	83 80	90 86	90 89

^{*} Mixed culture: Saccharomyces cerevisiae and Brettanomyces clausenii. **Saccharifications are expressed in percent of theoretical conversion.

Water Balance

PFD-P101-A201			-	PFD-P101-A302			1
IN	STREAM	kg/hr	total	1N	STREAM	kg/hr	total
	101	34,477	10101		304	13,781	1
				1	302	121,909	
	211	23,080			551	6.640	
1	215	7,622	1		331	0,040	142,329
	216	18,191	i		222	444	142,525
			83,369	OUT	308	141	
OUT	220	62,902			502	139,868	
	520	19,472					140,009
			82,375	Total for PFD			2,320
Total for PFD		_	994				
15.0.1.0, 1, 12				PFD-P101-A307			
PFD-P101-A202				IN	STREAM	kg/hr	total
IN	CTDEAM	kg/hr	total		302A	111,360	
IIN	STREAM		total		307A	10,149	
	220	62,902			422	10,548	500
	219	61,082			422	10,540	132,057
	243	18,005			0000	404.000	132,007
1	245	13,821		OUT	302B	121,909	
	230	92,637			307B	10,149	
			248,447			_	132,057
OUT	247	28,353		Total for PFD			
	246	91,676					
	303	12,194		PFD-P101-A401			
	403	242		IN	STREAM	kg/hr	total
*	410	4.597			403	242	e
					430	783	
•	302	111,360	040 400		100		1,025
			248,423	OUT	433	866	1.020
Total for PFD			25	1 001		182	
					435	102	1,048
PFD-P101-A203			1				
IN	STREAM	kg/hr	<u>total</u>	Total for PFD	and the second second		(23)
	246	91,676					
			91,676	PFD-P101-A402			
OUT	230	92,637		IN	STREAM	kg/hr	total
	229	207			410	4,597	
			92,844		433	866	
Total for PFD	1	•	(1,167)		411	7,777	
Total for 17 D	, 		(1,101)				13,240
PFD-P101-A301				OUT	419	1,537.	
	CTDEAN	Le me Cham	tatal	1	421	1,623	
IN	-	<u>kg/hr</u>	total		422	10,548	
	303	12,194	Ì		422	10,540	13,709
	421	1,623					(469)
	_		13,817	Total for PFD			(409
TUO	304c	8					
	304	13,781					
			13,789				
Total for PFD)		28				
				•			

PFD-P101-A501				PFD-P101-A601				PFD-P101-A901				
	STREAM	kg/hr	total	1N	STREAM	<u>kg/hr</u>	total	IN.	STREAM	<u>kg/hr</u>	<u>total</u>	
	501	139,868			6 04	36,924			941	75,268		
			139,868		516	13,919			945	5,553,810		
OUT	508	11			525	103,980			950	2,276,429		
	510	13,909	4		531	17,879					7,905,507	
	518A	125,948	1				172,702	OUT	949	64,004		
		_	139,868	OUT	219	61,082			940	5,553.810		
Total for PFD					411	7,777			942	4,422		
					430	783			944	6,842		
PFD-P101-A502					610	59.091			951	2,276,429	7.005.500	
IN	STREAM	kg/hr	total		601B	43,969	470 700	T-1-16 DCD			7.905,506 0	
1	304c	8		T-4-1 f DED		_	172.702	Total for PFD	 		U	
	308	141		Total for PFD		•	-	PFD-P101-A902				į
	508	11		PFD-P101-A602				1 IN	STREAM	kg/hr	<u>total</u>	ı
	524 510	6,564		IN	STREAM	kg/hr	total	314	904	79,972	<u>total</u>	1
		13,909		118	520	19,472	<u>total</u>		624	67,708		1
	521	. 879	21,512	·	535	10,342			52 4	01,700	147,680	
оит	550	83	21,312		494	6,842		OUT	524	6,786	,	i
001	551	6,640			821	2,699			811	29,678		
	516	13,919			247	28,353			604	36,924		1
	511	924			2	,	67,708		906	28		
	0.1	02.	21,565	OUT	624	67,708			941	75,268		
Total for PFD		_	(53)				67,708				148,685	
70.01.01.1				Total for PFD		_	-	Total for PFD			(1,005)	
PFD-P101-A503		1.44/4-0										
	STREAM	kg/hr	total	PFD-P101-A801								
	511	924		IN	STREAM	kg/hr	<u>total</u>		IN	OUT		
			924		813	80,536		Process Totals		9,531,285		
OUT	521	879	1				80,536	NET				
	515	45	ļ	OUT	815A	12,060			-0.01%	of in		
		-	924		215	7,622			m 1114 6			
Total for PFD					59 4 592	25,190 3,230			Facility S stream r			
					237	1,167			101	435		
PFD-P101-A504	0705444	1 11	1-1-1		596	229			904	419	OUT	
IN	STREAM	<u>kg/hr</u>	total		216	18,191		114,449	304	550	114,449	
	518A 610	125,948 59,091			307	10,149		,11 4,443		620	balance	
	010	J3,U3 I	185,039		821	2,699				949	0	
OUT	211	22,816	100,000		·	~,555	80,536			942	Ů	
	243	17,623		Total for PFD			0			229		
	245	13,664						•		601B		
	535	10,342		PFD-P101-A802						515		
	531	17,879		IN	STREAM	kg/hr	total					
	525	103,980			815A	12,060						
			186,303		811	29,678						
Total for PFD			(1,264)		593	3,230						
					595	25,190						
					307	10,149		A CONTRACTOR OF THE CONTRACTOR				
					597	229						
					821	2,699	00.00-	1				
					040	00.500	83,235					
				OUT	813	80,536						
					821	2,699	82 225					
				Total for DED		-	83,235	1				
				Total for PFD				1				

01 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		0 0 0 0 0 0 0 0 0 0 0 0 0	Bale conveyor Breaker Infeed Belt 1st Shredder Conveyor Ist Inkeed Belt 1st Shredder Conveyor 1st Inkeed Belt 2nd Shredder Conveyor 2nd Inteed Belt 3nd Shredder Conveyor Freed Screw Conveyor Fruck Scale Receiving Pad Front End Loader Bale Breaker Primary Stover Shredder	AREA0100	154 154 154 154 154 154 154 154 225,140 96 250,000	170 170 170 170 170 170 170 170 170 562,850 72	1,11 1,11 1,11 1,11 1,11 1,11 1,11 1,1	\$15,000 \$159,830 \$49,500 \$25,650 \$38,500 \$29,500 \$27,500 \$29,500	1999 1999 1999 1999 1999 1999	\$15,000 \$159,830 \$49,500 \$25,650 \$38,500 \$29,500	0.6 0.6 0.6 0.6	\$15,927 \$169,708 \$52,559 \$27,235	1.5 1.5	\$24,551 \$261,604	\$ 15,927 \$ 169,708	wire mesh conveyor 60" wide 20' long 16 degree, 38" x 200' radial stacker, 750 ton/hr, 75 HP	WC101 WC102	11.93 44.74 5.97	
03 1 04 1 06 1 06 1 07 1 08 1 09 1 01 2 02 1 03 6 04 3 05 i		0 0 0 0 0 0 0 0 0	Breaker Infeed Belt 1st Shredder Conveyor 1st Infeed Belt 2nd Shredder Conveyor 2nd Infeed Belt 3nd Shredder Conveyor 3nd Shredder Conveyor Feed Screw Conveyor Truck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100	154 154 154 154 154 154 154 225,140 96	170 170 170 170 170 170 170 562,850	1.51 1.11 1.11 1.11 1.11 1.11	\$49,500 \$25,650 \$38,500 \$29,500 \$27,500	1999 1999 1999 1999	\$49,500 \$25,650 \$38,500 \$29,500	0.6 0.6	\$52,559 \$27,235			\$ 169,708	16 degree, 36" x 200" radial stacker, 750 torvhr, 75 HP	WC102		
04 1 05 1 06 1 07 1 08 1 09 1 01 2 02 1 03 6 04 3 05 1		0 0 0 0 0 0 0 0 0	1st Sheedder Conveyor 1st Intead Belt 2nd Shreedder Conveyor 2nd inteed Belt 3nd Shreedder Conveyor Feed Strew Conveyor Feed Strew Conveyor Fruck Scale Receiving Pad Front End Loader Bale Brasker	AREADIDO	154 154 154 154 154 154 225,140 96	170 170 170 170 170 170 562,850	1.11 1.11 1.11 1.11 1.11	\$25,650 \$38,500 \$29,500 \$27,500	1999 1999 1999	\$25,650 \$38,500 \$29,500	0.6 0.6	\$27,235	1.5		1		t .	5.97	
04 1 05 1 06 1 07 1 08 1 09 1 01 2 02 1 03 6 04 3 05 1		0 0 0 0 0 0 0 0 0	1st Sheedder Conveyor 1st Intead Belt 2nd Shreedder Conveyor 2nd inteed Belt 3nd Shreedder Conveyor Feed Strew Conveyor Feed Strew Conveyor Fruck Scale Receiving Pad Front End Loader Bale Brasker	AREADIDO	154 154 154 154 154 154 225,140 96	170 170 170 170 170 170 562,850	1.11 1.11 1.11 1.11 1.11	\$25,650 \$38,500 \$29,500 \$27,500	1999 1999 1999	\$25,650 \$38,500 \$29,500	0.6 0.6	\$27,235	1.5		l				
06 1 06 1 07 1 08 1 09 1 01 2 02 1 03 6 04 3 05 i		0 0 0 0 0 0 0 0	1st Infeed Belt 2nd Shredder Conveyor 2nd Infeed Belt 3rd Shredder Conveyor Feed Screw Conveyor Freed Screw Conveyor Fruck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100	154 154 154 154 154 225,140	170 170 170 170 170 562,850	1.11 1.11 1.11 1.11	\$38,500 \$29,500 \$27,500	1999 1999	\$38,500 \$29,500	0.6			\$81,020		84" x 35' rubber belt cleated infeed conveyor, 10 HP, TEFC drive motor with guard	WC103		
06 1 07 1 08 1 09 1 01 2 02 1 03 6 04 3		0 0 0 0 0 0 1 0	2nd Shredder Conveyor 2nd Inteed Bell 3nd Shredder Conveyor Feed Screw Conveyor Fruck Scale Receiving Pad Front End Loader Bale Brasker	AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100	154 154 154 225,140 96	170 170 170 562,850	1.11 1.11 1.11	\$29,500 \$27,500	1999	\$29,500			1.5	\$41,983		BU' wide x 25' long, 10 HP, TEFC drive with guard	WC104	5.97	
07 1 08 1 09 1 01 2 02 1 03 6 04 3 05 1		0 0 0 0 0 1	2nd Inteed Belt 3rd Shredder Conveyor Feed Screw Conveyor Truck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100 AREA0100 AREA0100 AREA0100 AREA0100	154 154 225,140 96	170 170 562,850	1.11	\$27,500				\$40,879	1.5	\$63,015		60" wide x 30" long, 10 HP, TEFC drive with guard	WC105	11.93	
08 1 09 1 01 2 02 1 03 6 04 3 05 1		0 0 0 0 1	3rd Shredder Conveyor Feed Screw Conveyor Truck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100 AREA0100 AREA0100 AREA0100	154 225,140 96	170 562,850	1.11		1999		0.6	\$31,323	1.5	\$48,285		48" wide x 20" long, 7.5 HP, TEFC drive with guard	WC106	4 47	
09 1 01 2 02 1 03 6 04 3 05 1		0 0 0 1 0	Feed Screw Conveyor Fruck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100 AREA0100 AREA0100	225,140 96	562,850		\$29,500		\$27,500	0.6	\$29,200	1.5	\$45,011		48" wide x 30' long, 5 HP, TEFC drive with guard	WC107	2.95	
01 2 02 1 03 6 04 3 05 1		0 0 1 0	Fruck Scale Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100	96		2.50		1999	\$29,500	0.6	\$31,323	1.5	\$48,285		48" wide x 20' long, 10 HP, TEFC drive with guard	WC108	5.97	
02 1 03 6 04 3 05 i		0 1 0 0	Receiving Pad Front End Loader Bale Breaker	AREA0100 AREA0100		72		\$31,700	1997	\$31,700	0.6	\$54,932	1.5	\$86,351		14" dia. 250" long	WC109	53.75	
03 6 04 3 05 1		0 0	Front End Loader Bale Breaker	AREA0100	250,000		0.75	\$10,000	1999	\$20,000	0.6	\$16,829	1.5	\$25,244	\$ 16,829	96 deliveries /scale/12hr	-i		
04 3 05 1		0	Bale Breaker			250,000	1.00	\$2,083,500	1999	\$2,083,500	0.6	\$2,083,500	1.0	\$2,083,500	\$ 2,083,500	250,000 ft2 concrete pad, 9" thick with drainage	4		
05 i		0			159,948	159,948	1.00	\$156,000	1998	\$1,092,000	0.6	\$1,092,000	1.2	\$ 1,326,016	\$ 1,105,013	run on gasoline	-		
	-		Primary Stover Shreoker	AREA0100	154	170	1.11	\$250,000 \$106,300	1999	\$750,000	0.6	\$796,352	1.2	\$955,622	\$ 796,352	30 HP each	V/M104	53.69	
		U	Secondary Stover Shredder	AREA0100	154	170	1.11	\$106,300		\$106,300		\$112,870	1.2	\$135,444	\$ 112,870	250 HP, 1200 rpm, hammermill	V/M 105	149.14	
07 1									1999	\$106,300	0.6	\$112,870	1.5	\$169,304		250 HP, 1200 rpm, hammermill	WM106	149.14	
08 1			Shred Bunker Storm Runoff Pond	AREA0100 -AREA0100	1,747,767	1,747,767	1.00	\$700,000	1999	\$700,000 \$51,198	0.6	\$700,000	1.0	\$700,000	\$ 700,000	200x100x30ft bunker with three walls, 3 days shred storage	4		
			Istorm Kunon Pond	AREAUTO	1,747,767	1,/4/,/6/	1.00	\$51,198	1998			\$51,198		\$51,198	51,808	200 x 150 x 8 ft, 240,000ft3			295.80
^										weighted averages:	0.60		1.13				F	499 68	295.80
									Subtotal	\$5,315,978		\$5,418,705		\$6,146,434	\$5,433,414				
							200	Otpd x .45 (curre	int year c	ost with area weighted-av			1.3	\$3,181,636	(\$2,964,798)	is installed cost savings			
			T	T 2020000			1				Base Year =	1999				Y	_		
1	-+	0	In-line Sulfuric Acid Mixer	STRM0214	55,308	23,725	0.43	\$1,900	1997	\$1,900	0.48	\$1,266	1.2	\$1,585		Static Mixer, 110 gpm total flow	4		
1 1	-+	0	In-line NH3 Mixer	STRM0244	53,630	18,317	0,34	\$1,500	1997	\$1,500	0.48	\$896	1.2	\$1,122		Static Mixer, B2 gpm total flow			
19 1		0	Overliming Tank Agitator	STRM0228	167,050	102,608	0.61	\$19,800	1997	\$19,800	0.51	\$15,442	1.2	\$19,345		Top Mounted, 1800 rpm, 15 hp	WT209	8.39	11.11
24 1		0	Reacidification Tank Agitator	STRM0239	167,280	102,752	0.61	\$65,200	1997	\$65,200	0.51	\$50,851	1.2	\$63,702		Top-Mounted, 1800 rpm, 54 hp	WT224	25.17	44.49
32 1		0	Resturrying Tank Agitator	STRM0250	358,810	167,795	0.47	\$36,000	1997	\$36,000	0.51	\$24,432	1.2	\$30,606		Top-Mounted, 1800 rpm, 25 hp	W1232	13.98	11,99
35 1		0	In-line Acidification Mixer	STRM0236	164,570	101,104	0.61	\$2,600	1997	\$2,600	0.48	\$2,058	1.2	\$2,578		Static-Mixer, 440 gpm total flow	1		
21 1		0	Hydrolyzate Screw Conveyor	STRM0220	225,140	101,493	0.45	\$59,400	1997	\$59,400	0.78	\$31,908	1.5	\$50,158		18" dia, 33" long, 3420 cfh max flow, 23 hp	WC201	13.72	13.63
02 1	-	0	Wash Solids Screw Conveyor	STRM0225	196,720	165,453	0.84	\$23,700	1997	\$23,700	. 1	\$19,933	1.5	\$31,334		18" dia. 16' long, 3420 cfh max flow	ANC 303	16.70	16.42
25 1	-	0	Lime Solids Feeder					\$3,900	1997	\$3,900	1]	\$3,900	1.5	\$6,131	\$3,977		WC225	0.15	0.12
0 1		0	Hydrolyzate Cooler	AREA0200	1,988	895	0.45	\$45,000	1997	\$45,000	0.51	\$29,947	2.2	\$66,543		Fixed Tube Sheet, 900 sf, 20" dia, X 20" long			
1 1		1	Beer Column Feed Economizer	AREA0201	5,641	5,641	1.00	\$139,350	1999	\$278,700	0.68	\$278,700	2.2	\$607,278	\$278,700		1		
1 1		0	Prehydrolysis Reactor	STRM0217	270,034	121,514	0.45	\$12,461,841	1998	\$12,461,841	0.78	\$6,684,746	1.5	\$10,146,612	\$6,764,408		V/M105	353.16	353.16
1 1			Sulfuric Acid Pump	STRM0710	1,647	414	0.25	\$4,800	1997	\$9,600	0.79	\$3,228	2.8	\$9,190		2 gpm, 245 ft. head	WP201	0:40	0.27
9 1		_1	Overlimed Hydrolyzate Pump	STRM0228	167,050	102,608	0.61	\$10,700	1997	\$21,400	0.79	\$14,561	2.8	\$41,458		448 gpm, 150 ft. head	WP209	18,01	24.63
2 1		11	Filtered Hydrolyzate Pump	STRM0230	162,090	101,614	0 63	\$10,800	1997	\$21,600	0.79	\$14,936	2.8	\$42,526		448 gpm, 150 ft head	WP222	17 83	24.52
3 1		0	Lime Unloading Blower	STRM0227	547	337	0.62	\$47,600	1998	\$47,600	0.5	\$37,340	1.4	\$52,898	\$37,785		WP223	4.10	4.10
4 1		1	Hydrolysis Feed Pump	STRM0250	160,000	167,795	1.05	\$64,934	1999	\$129,868	0.6	\$133,628	1.2	\$160,354		740 gpm, 240 ft head	WP224	119.31	27.70
5 1		1	ISEP Elution Pump	STRM0243	52,731	18,005	0 34	\$7,900	1997	\$15,800	0.79	\$6,761	28	\$19,249		104 gpm, 150 ft head	WP225	3.92	3.55
6 1			ISEP Reload Pump	STRM0246	164,080	100,802	0.61	\$8,700	1997	\$17,400	0.79	\$11,841	2.8	\$33,714		445 gpm, 150 ft head	WP226	17.92	12.04
7 1		1	ISEP Hydrolyzate Feed Pump	STRM0221	160,290	98,157	0.61	\$10,700	1997	\$21,400	0.79	\$14,526	2.8	\$41,359		432 gpm, 150 ft head	WP227	16.81	24.12
9 1	-	1	Reacidified Liquor Pump	STRM0239	167,280	102,752	0.61	\$10,800	1997	\$21,600	0.79	\$14,698	2.8	\$41,847		450 gpm, 100 ft head	WP239	12.09	16.47
2 3		0	Pre-IX Belt Filter Press	SOLD0220	57,000	57,000	1.00	\$200,000	1998	\$600,000	0.39	\$600,000	1.4	\$850,010	\$607,150		WS202	19.69	19,19
1 1		0	ISEP	STRM0240	210,005	98,157	0.47	\$2,058,000	1997	\$2,058,000	0.33	\$1,601,194	1.2	\$1,959,422		10 chambers (39" dia. X. 84" high), 4" dia. Valve - Weak Base Resin	ViS221	2.98	2.24
2 1		0	Hydroclone & Rotary Drum Filler	STRM0229	5,195	1,137	0.22	\$165,000	1998	\$165,000	0.39	\$91,224	1,4	\$129,235		Hydrocyclone and Vacuum Filter for 453 gpm	WS222	11.93	11 60
7 1	-	0	LimeDust Vent Baghouse	STRM0227	548	337	0,61	\$32,200	1997	\$32,200	1	\$19,778	1.5	\$30,254		3750 cfm, 625 sf, 6 cfm/sf	_		
1 1	+		Sulfuric Acid Storage	STRM0710	1,647	B60	0.52	\$5,760	1996	\$5,760	0.71	\$3,633	1.7	\$6,283		2000 gal., 24 hr. residence time, 90% wv, 5.5ft diam. X 11ft	1		
3 1	4	0	Blowdown Tank	STRM0217	270,300	121,514	0.45	\$64,100	1997	\$64,100	0.93	\$30,475	1.7	\$52,061	\$31,078	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig	1		
9 1		0	Overtiming Tank	STRM0228	167,050	102,608	0.61	\$71,000	1997	\$71,000	0.71	\$50,232	1.8	\$90,186	\$51,225		_		
0 1	_	0	Lime Storage Bin	STRM0227	546	548	1.00	\$69,200	1997	\$69,200	0.46	\$69,200	1.8	\$124,243	\$70,568				
4 1		0	Reacidification Tank	STRM0239	102,752	102,752	1.00	\$111,889	1999	\$111,889	0.51	\$111,889	1.8	\$196,992	\$111,889	120,000 gal., 28' dia x 28' high, 4 hr. res. time, 90% wv., atmospheric			
2 1		0	Slurrying Tank	STRM0250	358,810	167,795	0.47	\$44,800	1997	\$44,800	0,71	\$26,117	1,8	\$46,890	\$26,633	11300 gal., 13' dia. X 25' high, 15 min. res. time, 90% wv	1		
			L	1			LI		1999						\$0		1 -		
										weighted averages:	0.70	\$0 000 117	1.48	£14 956 166	\$10 178 AQ2		1	676.27	621.55

 weighted averages:
 0.70
 1.48

 Subtotal
 \$16,527,758
 \$9,999,337
 \$14,955,166
 \$10,128,493

 2000/pd x .45 (current year cost with area weighted-average scale exponent applied)
 1.5
 \$15,025,380
 \$70,213
 is installed cost savings

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quip No.	No. Reg'd	No. Spare	Equip Name	Scaling Stream	Scaling Stream	New Stream Flow		Original Equip	Base Year	Total Original Equip Cost (Reg'd & Spare)	Scaling Exponent	Scaled Cost in Base Year	Install Factor	r installed Cost	Scaled Uninstalled Cost in 1999\$	Description	3442	work	NREL BOOTPD
<u> </u>	Wedn I	Opare		- Stream	1 1150 (115)	1		I a a contract a contract		1				1					
00	8	0	Fermentor Agitators	GALLONS	962.651	750,000	0.78	\$19,676	1996	\$157,408	0.51	\$138,592	1:2	\$175,799	\$143,110	Side Mounted, 2 per vessel, 60 hp each, 0.15 hp/1000 gal	Wt300	201.34	354.50
01	1	0	Seed Hold Tank Agitator	STRM0304	41.777	17.529	0.42	\$12,551	1996	\$12,551	0.51	\$8,060	1.2	\$10,223	\$8,322	Top Mounted, 1800 rpm, 10 hp, 0.1 hp/1000 gal	W1301 .	5.59	9.44
04	2	Ó.	4th Seed Vessel Agitator	STRM0304	41.777	17,529	0.42	\$11,700	1997	\$23,400	0.51	\$15,026	1.2		\$15,323	Top Mounted, 1800 rpm, 3 hp, 0.3 hp/1000 gal	WT304	3.36	4.72
05	2	0	5th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$10.340	1996	\$20,680	0.51	\$13,280	1.2	\$16,845	\$13,713	Top Mounted, 1800 rpm, 9 hp, 0.1 hp/1000 gal	WT305	10.07	15.73
06	ī	0	Beer Well Agitator	STRM0502	381,700	173,737	0.46	\$10,100	1997	\$10,100	0.51	\$6,761	1.2		\$6.894	Top Mounted, 1800 rpm, 2 hp. 0.3 hp/1000 gal	WT306	1.12	1.21
OO.	4	D	Fermentors	GALLONS	750.000	750,000	1.00	\$326,203	1999	\$1,304,812	0.71	\$1,304,812	1.8	\$2,297,260	\$1,304 812	750,000 gal, each, 2 day residence total, 90% wv, API, atmospheric, 50° à x 51°	┪		
01	2	0	1st Fermentation Seed Fermentor	None	1,00,000	1.50,550	0.45	\$14,700	1997	\$29,400	0.93	\$13,991	2.8		\$14.267	9 gal, jackeled, agitated, 1' dia., 1.5' high, 15 psig	-1		
02	2	0	2nd Fermentation Seed Fermentor	None		 	0.45	\$32,600	1997	\$65,200	0.93	\$31,027	2.8			90 gal., jacketed, agitated, 2' 3" dia., 3' high, 2.5 psig	7		
03	2	0	3rd Fermentation Seed Fermentor	None		 	0.45	\$81,100	1997	\$162,200	0.93	\$77,186	2.8			900 gal., jacketed, agitated, 5' dia, 6.5' high, 2.5 psig	7		-
04	2	0	4th Fermentation Seed Fermentor	STRM0304	41.777	17,529	0,42	\$39.500	1997	\$79,000	0.93	\$35,225	1.7			9000 gal., 9' dia x 19' high, atmospheric	− 1		
05	2		5th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$147,245	1996	\$294,490	0.51	\$189,107	1.8			90000 gal., API, atmospheric 25'è x 25'	-		1
00	4	-	Fermentation Cooler	QHX300EA	67 820	25,053	0.37	\$4,000	1997	\$20,000	0.78	\$9,198	2.2			1 4 exchangers at 221 sf, U=300 BTU/hr sf F LMTD = 22.9°F plate and frame	┥		1
O1	-7		Fermentation Seed Hydrolyzate Cooler	AREA0301	773	318	0.41	\$15,539	1998	\$15,539	0.78	\$7,778	2.2			348 sf, 300 BTU/hr sf F	7		
02	\rightarrow	0	Fermentation Pre-Cooler	AREA0302	3.765	828	0.22	\$25,409	1998	\$25,409	0.78	\$7,797	2.2			828 sf total, plate and frame	┨ '		
04		 -	4TH Seed Fermentor Coils	QSDF0301	38.339	15,789	0.41	\$3 300	1997	\$3,300	0.83	\$1,580	1.2			12 sf, 1" sch 40 pipe, 105 BTU/hr sf F			Į.
05		- 0	5TH Seed Fermenter Coils	QSDF0301	38.339	15,789	0.41	\$18,800	1997	\$18,800	0.98	\$7,881	1.2		\$8.037		7		1
00	4		Fermentation Recirc./Transfer Pump	QHX300EA	67.737	55.505	0.82	\$8.000	1997	\$40,000	0.79	\$34,177	2.8			2 844 gpm 20 150 ft sized based on heating rate	WP300	104.49	277.00
01	1	- 	Fermentation Seed Transfer Pump	STRM0304	41.777	17,529	0.42	\$22,194	1998	\$44,388	0.73	\$24,158	1.4			280 gpm @ 150 ft head	WP301	5.95	6.92
07	2		Seed Transfer Pump	STRM0304	41.777	17,529	0.42	\$54,088	1998	\$108,176	0.7	\$58.898	1.4			1 504 gpm total, 252 gpm each, 100 ft head	WP302	7.14	6.92
06	1		Beer Transfer Pump	STRM0502	381,701	173,737	0.42	\$17,300	1997	\$34,600	0.79	\$18.579	2.8			790 gpm each, 171 ft head	WP306	34.47	45.74
21	-;		Fermentation Seed Hold Tank	STRM0304	41.777	17.529	0.42	\$161.593	1998	\$161.593	0.79	\$103,767	1.8			1 05000 gal., API atmospheric	٠,,, ٥	34.47	
20	1	0	Seer Well	STRM0502	129,000	183,467	1.42	\$111.889	1999	\$101,393 \$111.889	0.51	\$133.906	1.8			192,518 gal., 32' dia x 32' high, 4 hr, res, time, 95% wv, atmospheric			
<u>~</u>	'1	<u> </u>	paer vveir	31RM0302	129,000	103,407	1.42	\$111,005	1333	weighted averages:	0.68	1133,300	1.79		1 4155,500	1 132,310 gar., 32 dia x 32 high, 4 hi, 163, bille, 33 x 47, ashospheric		373.53	722.18
07	8 1	0	Enzymatic Hydrolysis Tank Agitators	STRM0302B	157,136	157,136	1.00	\$19,676	ntyearc	ost with area weighted-av	verage scale e	xponent applied)	1.3			is installed cost savings I two side mounted 75 hp agitators / tank, 0.4hp/1000 gal.		251.67	1
07	12	0	Enzymatic Hydrolysis Tank Heater	STRM03028	157,136	157,136	1.00	\$15,000	1999	\$180,000	0.78	\$180,000	2.2	\$392,214	\$180,000	65 ft2 double pipe	7		- 1
08	1	0	Pre-hydrolyzate cooler	STRM0302	145,536	145,536	1.00	\$25,000	1999	\$25,000	0.78	\$25,000	2.2	\$54,474	\$25,000	481 ft2, parallel double pipe	7		
08	8	1	Hydrolyzer Battoms Pump	STRM03028	157,136	157,136	1.00	\$121,690	1999	\$1,095,210	0.6	\$1.095,210	1.2	\$1,314,252	\$1,095,210	3000 GPM each Disc flow pumps, 245ft head	WP308	1,744.94	.1.
T F					†	1										3/5,000 gallons, 24 hour residence time, 2 side mounted agitators cone bottom,	-1		1
07	4	0	Enzymatic Hydrolysis Tank	STRM03028	750,000	375,000	0.50	\$326,203	1999	\$1,304,812	0.6	\$860,855	2.0	\$1,753,728	\$860,855	5 concrete base, bottom outlet through the concrete, 30° cone bottom	_1		
		0							1999						\$0		1		
							1	• •		weighted averages:	0.61		1.60				1	1,996.61	
a 307									ubtotal	\$2,762,430		\$2,318,473		\$3,714,334	\$2,323,604				
							20	000tpd x .45 (curre	nt vear c	ost with area weighted-av	veraoe scale e	(beildas Inenex		\$0	(\$3,714,334)	is installed cost savings			
									-	•	•					Cost Savings with SHCF (sum of A300 & A307 savings)			
00	11 1	0	Cellulase Fermentor Agitators	GALLONS	150,000	88,335	0.59	\$200,000	1999	\$2,200,000	0,51	\$1,679,359	1.2	\$2,062,956		125 hp / agitator 1 agitator/vessel	WT400	559 28	1,373 10
						1	-									88335 gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20 ft.	7		
oo f	11	0	Cellulase Fermentors	GALLONS	88,335	88,335	1.00	\$179.952	1998	\$1,979,472	0.71	\$1,979,472	1.8	\$3,525,602	\$2,003,061	diameter	1		
01	3	0	1st Cellulase Seed Fermentor	STRM0433	2 790	932	0,33	\$22,500	1997	\$67 500	0.93	\$24,343	2.0	\$49.648		11 gal / 15 psig / Jacketed / Agitator	7		
12	3	0	2nd Cellulase Seed Fermentor	STRM0433	2,790	932	0.33	\$54,100	1997	\$162,300	0.93	\$58,531	2.0			221 gal / 15 psig / Jacketed / Agitator	W7402	119 82	149.78
13	3	0	3rd Cellulase Seed Fermentor	STRM0433	2.790	932	0.33	\$282,100	1997	\$846,300	0.93	\$305,207	2.0			4417 gal / 15 psig / Jacketed / Agitator	-		
00	11		Cellulase Fermentation Cooler	QHX400EA	236.668	88.335	0.37	\$34,400	1997	\$378,400	0.78	\$175,431	2.2		\$178 899				
01	5	- 1	Fermentor Air Compressor Package	STRM0440	80,455	80,455	1.00	\$229,000	1999	\$1,374,000	0.34	\$1,374,000	1.3			7946 sc/m each, 50 psig outlet, 1277 hp each, includes starter		5,108.00	5,370.92
00	1	-	Cellulase Transfer Pump	STRM0420	40.543	11,600	0.29	\$9,300	1997	\$18,600	0.79	\$6,921	2.8			58 GPM / 100 ft. head	WP400	1.57	2.22
51	+ 1	1	Cellulase Seed Pump	STRM0420	2.790	932	0.33	\$12,105	1998	\$24,210	0.73	\$11,236	1.2			24 gpm / 1 hp	WF 401	0.28	0.31
05			Media Pump	STRM0416	586	200	0.34	\$8,300	1997	\$16,600	0.79	\$7,104	2.8			21 Gpm/100 Ft Head	WP405	0.09	0.03
20			Anti-foam Pump	STRM0417	227	79	0.35	\$5,500	1997	\$11,000	0.79	\$4,761	2.8			4 gpm / 75 ft head	WP423	0.01	0.01
05		<u></u>	Media-Prep Tank	STRM0417	586	200	0.33	\$64,600	1997	\$64,600	0.71	\$30,128	1.7			3 2083 Gal / 1,17 hp Agitator	V-7 402	0.65	85.84
20	1	0	Anti-foam Tank	STRM0417	227	79	0.35	\$402	1998	\$402	0.71		1.7			2 67 gat, 3 hr, residence time		0.00	. 20.01
	_ '1	<u> </u>	Para Iodini rank	1 0110W0411	1 221	/3	1 5.33	1 3402 1	,,,,,,	weighted averages:	0.61	3109	1.52		4102	Tor yes, a in , residence units	-{ : : : .	5,789.71	6.982.21
OG-									Subtotal	\$7,143,384	0,01	\$5,656,682	1.32	\$8,676,000	\$5,692,516		ı	0,, 00	
-								`		\$1,140,004		from Pfpve,xls/0,4	15 equir	\$10,353,995		Installed Cost Savings Using PureVision Enzyme Production Technology			
													vigorji.	* (5,555,554	***********				

2 of 4

						New									Scaled		Ì		
quip	No.	No.	1	Scaling	Scaling Stream			Original Equip			Scaling	Scaled Cost In	instali		Uninstalled Cost		l l	İ	NREL
No.	Req'd	Spare	Equip Name	Stream	Flow (Kg/hr)	Flow	Ratio	Cost (per unit)	Year	Cost (Req'd & Spare)	Exponent	Base Year	Factor	Installed Cost	in 1999\$	Description	3442	WORK	900TPD
501	1	0	Beer Column	DIAMD501	1 4	2.29	0.56	\$636,976	1996	\$636,976	0.78	\$402.792	2.1	\$873,434	£415 921	7'6" DIA, 32 ACTUAL TRAYS, NUTTER V-GRID TRAYS	-1		1
502	- - +	- 0	Rectification Column	55105521	56.477	26,744	0.47	\$525,800	1996	\$525,800	0.78	\$293,491	2.1		\$303.058		⊣ .		1
501	1		1st Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,676	1996	\$435,676	0.68	\$435,676	2.1		\$449,877				ľ
502	,		2nd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.1		\$449.850				ŀ
503	1	<u> </u>	3rd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.1		\$449.850				
501	+ 1	- -	Beer Column Reboiler	QRFD0501	-7,863,670	-3,723,722	0.474	\$158,374	1996	\$158,374	0.68	\$95,263	2.2		\$98.368				- 1
502	\rightarrow		Rectification Column Reboiler	QRFD0502	-987.427	-467,581	0.474	\$29,600	1997	\$29,600	0.68	\$17.805	2.2		\$18,157				1
504		0	Beer Column Condenser	QCND0501	277.820	131,557	0.474	\$29,544	1996	\$29,544	0.68	\$17,771	2.2		\$18,350		⊣		1
505			Rectification Column Condenser	QCND0502	4.905.410	2,322,883	0.474	\$86,174	1996	\$86 174	0.68	\$51,834	2.2		\$53.524				
512			Beer Column Feed Interchange	AREA0512	909		-										⊣]
	- - +					430	0.474	\$19,040	1996	\$38,060	0.68	\$22,905	2.2		\$23,652				1
517			Evaporator Condenser	QHET0517	6,764,222	3,203,095	0.47	\$121,576	1996	\$243,152	0.68	\$146,257	2.2	\$329,077	\$151,024	Fixed TS, 3906 sf, 29" dia., 20" long, 220 BTU/hr sf F			- 1
	. 1	_	I		1					1						Superheater, twin mole sieve columns, product cooler, condenser, pumps, vacuum			
503		- 0	Molecular Sieve (9 pieces)	STRM0515	20,491	9,703	0 47	\$2,700,000	1998	\$2,700,000	0.7	\$1,599,964	1.0	\$1,619,030	\$1,619,030		WM503	55.00	55.00
601		1	Beer Column Bottoms Pump	P501FLOW	5,053	2,200	0.44	\$42,300	1997	\$84,600	0.79	\$43,861	2.8	\$124,881		2200 gpm, 150 ft head	WP501	84.65	118.68
03	1 1	1	Beer Column Reflux Pump	QCND0501	277,820	131,557	0.47	\$1,357	1998	\$2,714	0.79	\$1,504	2.8			6 gpm, 140 ft head	WP503	0.22	0.51
04		1	Rectification Column Bottoms Pump	STRM0516	31,507	15,530	0.49	\$4,916	1998	\$9,832	0.79	\$5,622	2.8	\$15,884		76 gpm, 158 ft head	WP504	2.80	3.46
05	1	1	Rectification Column Reflux Pump	QCND0502	4,906,301	2,323,304	0.47	\$4,782	1998	\$9,564	0.79	\$5,299	2.8	\$14,970		207 gpm, 110 ft head	WP505	5.14	12.77
511	2	1	1st Effect Pump	STRM0525	278,645	133,617	0.48	\$19,700	1997	\$59,100	0.79	\$33,069	2.8	\$94,155		1137 gpm each, 110 ft head	WP511	67.89	B0.57
12	1	1	2nd Effect Pump	STRM0528	91,111	45,390	0.50	\$13,900	1997	\$27,800	0.79	\$16,032	2.8	\$45,646		599 gpm, 110 ft head	WP512	17.37	19.12
113	2	_ 1	3rd Effect Pump	STRM0531	48,001	23,814	0.50	\$8,000	1997	\$24,000	0.79	\$13,795	2.8	\$39,276		196 gpm each, 110 ft head	WP513	12.54	10.26
114	1	1	Evaporator Condensate Pump	STRM534A	140,220	69,285	0 49	\$12,300	1997	\$24,600	0.79	\$14,095	2.8	\$40,131		293 gpm, 125 ft head	WP514	9.20	12.43
115	1 1	1	Scrubber Bottoms Pump	STRM0551	15,377	7,427	0.48	\$2,793	1998	\$5,586	0.79	\$3,143	2.8	\$8,881	\$3,181	31 gpm, 104 ft head	WP515	0.84	0.77
17	1	1	Kill Tank Bottoms Pump	STRM0518	5,053	660	0.13	\$42,300	1997	\$84,600	0.79	\$16,944	2.8	\$48,242	\$17,279	660gpm, 72 ft head	WP517	12.19	
Ю3	_1]	0	Beer Column Relfux Drum	QCND0501	277,820	131,557	0.47	\$11,900	1997	\$11,900	0.93	\$5,938	1.7	\$10,144		164 gal, 15 min res. Time, 50% wv, 2'6" dia., 5' long, 25 psig	7		Į.
05	1	0	Rectification Column Reflux Drum	QCND0502	4,906,301	2,323,304	0.47	\$45,600	1997	\$45,600	0.72	\$26,621	1.7	\$45,476	\$27,147	6225 gal, 15 min res time, 50% wv, 7' dia, 22' long, 25 psig	7		i
12	1	Ū.	Vent Scrubber	STRM0523	18,523	9,788	0.53	\$99,000	1998	\$99,000	0,78	\$60,197	1.7	\$102,043	\$60,915	5' dia x 25' high, 4 stages, plastic Jaeger Tri-Packing	7		1
13	1 1	0	Kill Tank	STRM0518	149,897	149,897	1.00	\$99,920	1999	\$99,920	0.78	\$99,920	1.7	\$167,384	\$99,920	18 psig, 30 min. res. time] .		
										weighted averages:	0.72		1.71				1	267.85	313.57
00								5	Subtotal	\$6,343,492		\$4,301,097		\$7,515,486	\$4,400,972				
							20	000tpd x .45 (curre	nt year c	cost with area weighted-av	erage scale ex	ponent applied)	1.7	\$6,765,614	(\$749,872)	is installed cost savings			
i01	1	0	Lignin conveyor	STRM06018	225.140	225,140	1.00	\$31,700	1997	\$31.700	0.6	\$31,700	1.5	\$49,832	\$ 32,327	14" dia, 100' long	VAC109	21,50	1
613	7	0	Syrup Sprayer	STRM0531	22,372	22.372	1.00	\$1,000	1999	\$1,000		\$1,000	1.2	\$1,200		100 GPM syrup sprayer	-		ļ
514	1		Lignin Loadout	STRM0601A	63,778	0	0.00	\$41,200	1999	\$41,200	0.3	\$0	1.0	\$0		245 GPM @ 20,6% insoluble solids	-1		1
-			1	- CTTTMODDIX	0.5,170	 	0.00	341,200	1000	\$11,200			1.0	***		no less than 500,000 gal., above-ground bolted tank with cover, including			
615	1	0	Equalization Basin	STRM0830	98.267	102,204	1.04	\$350,000	1999	\$350,000	0.79	\$361.031	10	\$361,031	\$361.031	foundations, pumps and controls	354615	1,077 21	
316	1	0	Anaerobic Digestion System	STRM0630	98.267	102,204	1.04	\$3,200,000	1999	\$3,200,000	0.79	\$3,300,852	1.0	\$3,300,852		500,000 gal, includes site work, foundations, reactors and ancillary equipment	-	-,	1
-			7 - Mariodic Digustan System	017/11/00/00	30,201	102,204	1.07	\$3,200,000	1333	0.00,000,CQ	0.13	\$3,380,032	1.0	\$5,500,652	\$3,300,032	four-350,000 gal. Sequencing Batch Reactors, 48,000 lbs/day of O ₂ transfer	-		
			İ			l	1	l l							ì				- 1
517		0	Aerobic Digestion System	STRM0830	98.267	102,204	1.04	\$4,300,000	1999	\$4,300,000	0.79	\$4,435,520		\$4,435,520	******	capability, de-nitrification facilities, aeration and mixing requires approximately 1.400 horsepower			
/ · · · · ·			Aerobic digestori system	31KM0630	95,201	102,204	1.04	\$4,300,000	1999	\$4,300,000	0.79	\$4,435,520	1.0	\$4,435,520	\$4,435,520		⊣		
618	7	0	Pressure Sand Filters	STRM0830	96.267	102,204	1.04	\$280,000	1999	\$280,000	0.79	\$288.825	1.0	\$288.825	\$288.825	400 ft ² of filtration surface area, includes the engineering and legal cost to acquire an NPDES permit			
30	1	1	Recycle Water Pump	STRM0602	179.446	84,120	0.47	\$10,600	1997	\$21,200	0.79	\$11,652	2.8	\$33,175	\$11.892	370 gpm, 150ft head	WP630	14.75	
01	2	<u> </u>	Beer Column Bottoms Centrifuge	CENTFLOW	404	300	0.74	\$659,550	1998	\$1,319,100	0.6	\$1,103,371	1.2	\$1,339,824		requires 540gpm duty, 2 @ 300 gpm and 410 hp each	WS601	489.18	400 03
30	1	-0	Recycled Water Tank	STRM0602	179.446	84.120	0.47	\$14,515	1996	\$14,515	0.745	\$8,254	1.7	\$13,992		7410 gal, 20 min, res., 2.5 psiq, 9.5ft diam, x 14.25ft	- ···~	, 103, 10	
				1		1 01,120		* *******		weighted averages:	0.76	*0,204}	1,03	1.5,552	40,000	L den	<u>1</u> .	1,602,64	690.39
00									Subtotaf		5.70	\$9,542,206	1.03	\$9,824,251	\$9,556,310		F	,,	555.55
Ī -							. ~	V00444 45 /	·	*************		45,041,200		\$9,024,231	\$5,556,510 (\$4,656,010)				

1.3 \$5,167,342

(\$4,656,910) is installed cost savings

2000tpd x .45 (current year cost with area weighted-average scale exponent applied)

I:\PROCESS\3442\PFD\Equipa

quip	No.	No.		Scaling	Scaling Stream		Size	Original Equip	Base		Scaling	Scaled Cost In	install		Uninstalled Cost	1.		1	NREL
No.	Req'd	Spare	Equip Name	Stream	Flow (Kg/hr)	Flow	Ratio	Cost (per unit)	Year	Cost (Req'd & Spare)	Exponent	Base Year	Factor	Installed Cost	in 1999\$	Description	3442	WORK	900TPD
03 T			10.0		·	1	T			,						7			
07		1	Sulfuric Acid Pump Antifoam Store Pump	STRM0710	1,647	1,912	1.16	\$8,000	1997	\$16,000	0.79 0.79	\$18,001	2.8			215 gpm, 150ft head	WP703	0.09	0.09
20	1	 	CSL Pump	STRM0417	227	79	0,35	\$5,700	1997	\$11,400		\$4,934	2.8			0.5 gpm, 92 ft head	WP707	0.01	0.01
03	-:-	1		STRM0735 STRM0710	2,039	859	0.42	\$8,800	1997	\$17,600	0.79	\$8,889	2.8	\$25,308		182 gpm, 150ft head	WP720	0.15	0.18
03			Sulfuric Acid Storage Tank		1,647	1,912	1.16	\$42,500	1997	\$42,500	0.51	\$45,860	1.8	\$82,338		20,000 gal, 240 hr supply, 90% wv, 12ft diam, x 24 ft, atmospheric			- 1
20		0	Antifoam Storage Tank CSL Storage Tank	STRM0417	227	227	1.00	\$14,400	1997	\$14,400	0.71 0.79	\$14,400	1.7			12,000 gal, 27 day supply, 10.5ft diam. X 18.5ft			1
20			CSL Storage Tank	STRM0735	2,039	859	0.42	\$88,100	1997	\$88,100		\$44,495	1.7	\$76,011	\$45,375	30160 gal, 90% wv, 120 supply, 14.3ft diam. X 25 ft			
30										weighted averages:	0.72		1.96				1	0 25	0.28
,,,									Subtotal			\$136,579		\$273,557	\$139,279				
							20	000tpd x .45 (curr	ent year o	cost with area weighted-av	erage scale e	(ponent applied)	1.5	\$1,220,544	\$946,987	is installed cost savings			
				STRMO815+	T		T			Т				1		200,000 W/hr running @ 171,488 W/hr; with 40,000 W/hr 160° superheat; 132,000 W/hr	-		1
02		,	Boiler with Superheater	216															
03	-	0	Hot process water softener system		200,000	200,000	1,00	\$1,590,000	1999	\$1,590,000	0.7	\$1,590,000	1.3			390° sat. @ 205 psig	VVM803	75.60	75.60
30	1	0		STRM0811B	229,386	45,003	0.20	\$1,383,300	1999	\$1,383,300	0.6	\$520,623	1.2		\$520,623			1	
		0	Hydrazine Addition Pkg.	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1.D 1.0	\$10,857		75 gal tank, agitator, 2 metering pumps	VVM830	10.00	10.00
32			Ammonia Addition Pkg	STRM813A	229,386	80,536	0 35	\$19,000	1994	\$19,000	0.6	\$10,139				75 gal tank, agitator, 2 metering pumps	WM832	10.00	10.00
34		0	Phosphate Addition Pkg.	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$ 10,139	1.0			75 gal tank, agitator, 2 metering pumps	VVM834	.10.00	10.00
04	2		Condensate Pump	STRM811A	249,633	38,798	0.16	\$7,100	1997	\$21,300	0.79	\$4,894	4.6			130 gpm, 150' head	WP804	9.21	7.66
24	2		Deaerator Feed Pump	STRM811A	196,000	38,798	0.20	\$9,500	1997	\$28,500	0.79	\$7,927	8.3	\$67,097		180 gpm, 115' head	WP824	4.89	2.27
26	4	1	BFW Pump	STRM0813	207,310	80,536	0.39	\$52,501	1998	\$262,505	0.79	\$124,377	1.4	\$176,203		310 gpm, 2740' head	WP826	400.99	399.04
28	_1	1	Blowdown Pump	STRM0821	6,600	2,699	0.41	\$5,100	1997	\$10,200	0.79	\$5,032	6.4	\$32,842		12 gpm, 150 head	WP828	0.42	.0.93
30	1	1	Hydrazine Transfer Pump	STRM813A	229,386	80,536	0.35	\$5,500	1997	\$11,000	0.79	\$4,811	6,4	\$31,402		3 gpm, 75' head	WP830	0.05	0.01
м	1	0	Condensate Collection Tank	STRM811A	229,386	38,798	0.17	\$7,100	1997	\$7,100	0.71	\$2,011	3.3	\$6,766		200 gal, 1.5 min. res. time			
24	_1[0	Condensate Surge Drum	STRM811A	150,000	38,798	0.26	\$49,600	1997	\$49,600	0.72	\$18,734	5.0	\$95,523	\$19,105	2100 gal., 6' diam. X 10', 15 psig, res. time 11 min.	1		
26	1 1	0	Deaerator	STRM0813	267,000	80,536	0.30	\$165,000	1998	\$165,000	0.72	\$69,616	6.5	\$457,896	\$70,446	3030 gal., 15 psig, 10 min. res.	_[- 1
28		0	Blowdown Flash Drum	STRM0621	6,550	2,699	0.41	\$9,200	1997	\$9,200	0.72	\$4,859	7.3	\$36,168	\$4,955	210 gal., 2,5' diam. X 6', 50 psig 17 min. res.	_1		
30	1	0	Hydrazine Drum	STRM813A	229,386	80,536	0.35	\$12,400	1997	\$12,400	0.93	\$4,685	7.0	\$33,440	\$4,777	138 gal, 3.75' x 1.25' diam., 10 psig	7		
										weighted averages:	0.67		1.54				7	521.16	515.51
10									Subtotal	\$3,607,105		\$2,387,986		\$3,684,612	\$2,393,497		•		
				•			20	00tpd x .45 (curr	int year o	ost with area weighted-av-	erage scale ex	(ponent applied)	1.1	\$23,046,972	\$19,362,360	is installed cost savings			
										-									
02	_11	0	Cooling Tower System	QCWCAPIT	41,100,000	12,955,985	0.32	\$1,659,000	1998	\$1,659,000	0.78	\$674,181	1.2	\$818,659	\$682,216	40,000 gpm, 185.4MM BTU/hr	V/M902	298.85	306.51
)4	1	0	Plant Air Compressor	STRM0101	159,950	159,950	1.00	\$60,100	1997	\$60,100	0.34	\$60,100	1.3	\$79,675	\$61,288	450 cfm, 125 psig outlet	V/M904	186.40	186.40
8	1	0	Chilled Water Package	QCHLWCAP	5,040,000	2,268,000	0,45	\$380,000	1997	\$380,000	0.8	\$200,610	1.2	\$245,492	\$204,577	1000 ton, 600kW	VVM908	600.00	507.11
10	1	0	CIP System	STRM0914	63	28	0.45	\$95,000	1995	\$95,000	0.6	\$58,837	1.2	\$73,021	\$60,851	designed by Delta-T, (est 0.2 kW)	W###10	0.20	-
12	1	1	Cooling Water Pumps	STRM0940	18,290,000	5,553,791	0.30	\$332,300	1997	\$664,600	0.79	\$259,201	2.8	\$737,993		12300 gpm, 70ft head			
2	1	1	Make-up Water Pump	STRM0904	244,160	82,445	0.34	\$10,800	1997	\$21,600	0.79	\$9,151	2.8	\$26,084		370 gnm, 75ft head	WP912	7.32	8.00
4	1	1	Process Water Circulating Pump	STRM0905	352,710	111,503	0.32	\$11,100	1997	\$22,200	0.79	\$8,938	2.8	\$25,449		745 gpm, 75ft head	WP914	14.78	22.38
4	1	1	Instrument Air Dryer	STRM0101	159,950	71,977	0.45	\$15,498	1999	\$30,996	0.6	\$19,197	1.3	\$24,956		134 scfm air dryer, -40F Dewpoint	WS601	4.91	4.91
4	1	0	Plant Air Receiver	STRM0101	159,950	53,316	0.33	\$13,000	1997	\$13,000	0.72	\$5,894	1.7	\$10,069		300 gal., 200 psig	-		ł
4	1	0	Process Water Tank	STRM0905	352,710	111,503	0.32	\$195,500	1997	\$195,500	0.51	\$108.663	1.8	\$195,095		234360 gal, 8hr res. time	-1		
			•		*		•			weighted averages:	9,75		1.57			400 gpm well pump, 500ft head	53.16	1,165.62	1,035.31
900									Subtotal	\$3,141,996		\$1,404,783		\$2,236,491	\$1,427,733		Total kW	12,893	11,177
							20	00tpd x .45 /ours	nt vear	ost with area weighted av	erane scale ev		1.3	\$2,895,441		is installed cost savings		,,1	
									, , , , , ,			.p	1.0	**,000,***	*********	11 CONTRACTOR OF THE STATE OF T			

3442 PLANT TOTAL:		\$57,333,793	\$43,406,643	\$61,054,640
45% NREL TOTAL:				\$75,675,432
SAVINGS:				\$14,820,792
	 			19.53%

•	Equip No.	No. Req'd	No. Spare	Equip Name	Scaling Stream	Scaling Stream Flow (Kg/hr)	New Stream Flow	Size Ratio	Original Equip Cost (per unit)	Base Year	Total Original Equip Cost (Req'd & Spare)		g Scaled Cos		Installed Cost	Scaled Uninstalled Cost in 1999\$	Description
D-P100-A201	A-201	1	0	In-line Sulfuric Acid Mixer	STRM0214	55,308	23,725	0.43	\$1,900	1997	\$1,900	0.4		1.23	\$1,585	\$1,291	Static Mixer, 110 gpm total flow
D-P100-A202	A-202	1	0	In-line NH3 Mixer	STRM0244	53,630	18,317	0.34	\$1,500	1997	\$1,500	0.4		1.23	\$1,122		Static Mixer, 82 gpm total flow
D-P100-A203	A-209	1	0	Overliming Tank Agitator	STRM0228	167,050	102,608	0.61	\$19,800	1997	\$19,800	0.5		1.23			Top Mounted, 1800 rpm, 15 hp
D-P100-A203	A-224	1	0	Reacidification Tank Agitator	STRM0239	167,280	102,752	0.61	\$65,200	1997	\$65,200	0.5		1.23			Top-Mounted, 1800 rpm, 54 hp
D-P100-A202	A-232	1	0	Reslurrying Tank Agitator	STRM0250	358,810	167,795	0.47	\$36,000	1997	\$36,000	0.5		1.23	\$30,606		Top-Mounted, 1800 rpm, 25 hp
D-P100-A203	A-235	1	0	In-line Acidification Mixer	STRM0236	164,570	101,104	0.61	\$2,600	1997	\$2,600	0.4			\$2,578		Static-Mixer, 440 gpm total flow
D-P100-A302	A-300	8	0	Fermentor Agitators	GALLONS	962,651	750,000	0.78	\$19,676	1996	\$157,408	0.5		1.23	\$175,799		Side Mounted, 2 per vessel, 60 hp each, 0.15 hp/1000 gal
D-P100-A301	A-301	1	0	Seed Hold Tank Agitator	STRM0304	41,777	17,529	0.42	\$12,551	1996	\$12,551	0,5		1,23			Top Mounted, 1800 rpm, 10 hp, 0.1 hp/1000 gal
D-P100-A301	A-304	2	0	4th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$11,700	1997	\$23,400	0.5		1.23	\$18,824		Top Mounted, 1800 rpm, 3 hp, 0.3 hp/1000 gal
D-P100-A301 D-P100-A302	A-305	2	0	5th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$10,340	1996	\$20,680	0.5		1.23	\$16,845		Top Mounted, 1800 rpm, 9 hp, 0.1 hp/1000 gal
D-P100-A302	A-306 A-307	8	0	Beer Well Agitator	STRM0502 STRM0302B	381,700	173,737	0.46	\$10,100	1997	\$10,100	0.5		1.23	\$8,469		Top Mounted, 1800 rpm, 2 hp, 0.3 hp/1000 gal
D-P100-A402	A-400	11	0	Enzymatic Hydrolysis Tank Agitators Cellulase Fermentor Agitators	GALLONS	157,136 150,000	157,136 88,335	1.00 0.59	\$19,676 \$200,000	1996 1999	\$157,408	0.5 0.5		1.23	\$199,666		two side mounted 75 hp agitators / tank, 0.4hp/1000 gal. 125 hp / agitator 1 agitator/vessel
77 100 7402	A-400	39	0	39	GACLONS	130,000	00,335	0.59	\$200,000	1999	\$2,200,000	0.5	\$1,679,359	1.23			125 np / agriator 1 agriator/vesser
	~~~~	sum	sum	total												\$ 66,967 avg. (installed)	
)-P100-A101	C-101	1	0	Bale conveyor	AREA0100	154	170	1.11	\$15,000	1999	\$15,000	0.4	\$15,927	avg.	sum \$24,551		wire mesh conveyor 60" wide 20' long
D-P100-A101	C-102	1	0	Radial Stacker Conveyor	AREA0100	154	170	1.11	\$159,830	1999	\$159,830	0.0		1.54			16 degree, 36" x 200' radial stacker, 750 ton/hr, 75 HP
D-P100-A101	C-103	1	0	Breaker Infeed Belf	AREA0100	154	170	1.11	\$49,500	1999	\$49,500	0.	552,559	1.54	\$81,020	<b>\$</b> 52,559	84" x 35' rubber belt cleated infeed conveyor, 10 HP, TEFC drive motor with guard
P100-A101	C-104	1	0	1st Shredder Conveyor	AREA0100	154	170	1.11	\$25,650	1999	\$25,650	0.0		1.54	\$41,983		60" wide x 25' long, 10 HP, TEFC drive with guard
P100-A101	C-105	1	0	1st Infeed Belt	AREA0100	154	170	1.11	\$38,500	1999	\$38,500	0.0			\$63,015		60" wide x 30' long, 10 HP, TEFC drive with guard
)-P100-A101	C-106	1	0	2nd Shredder Conveyor	AREA0100	154	170	1.11	\$29,500	1999	\$29,500	0.0			\$48,285		48" wide x 20' long, 7.5 HP, TEFC drive with guard
P100-A101	C-107	. 1	0	2nd Infeed Belt	AREA0100	154	170	1.11	\$27,500	1999	\$27,500	0.0			\$45,011		48" wide x 30" long, 5 HP, TEFC drive with guard
P100-A101	C-108		0	3rd Shredder Conveyor	AREA0100	154	170	1.11	\$29,500	1999	\$29,500	0.0			\$48,285		48" wide x 20' long, 10 HP, TEFC drive with guard
P100-A101	C-109		0	Feed Screw Conveyor	AREA0100	225,140	562,850	2.50	\$31,700	1997	<b>\$</b> 31,700	0.0		1.54	\$86,351		14" dia. 250' long
-P100-A201 -P100-A202	C-201 C-202		0	Hydrolyzate Screw Conveyor	STRM0220	225,140	101,493	0.45	\$59,400	1997	\$59,400	0.7			\$50,158		18" dia. 33' long, 3420 cfh max flow, 23 hp
-P100-A202	C-202	1	0	Wash Solids Screw Conveyor Lime Solids Feeder	STRM0225	196,720	165,453	0.84	\$23,700	1997	\$23,700	1.00			\$31,334		18" dia, 16' long, 3420 cfh max flow
P100-A601	C-223		0	Lignin conveyor	none STRM0601B	225,140	225,140	1.00	\$3,900	1997	\$3,900		\$3,900		\$6,131		6" dia., 63 cfh, 3150 lb/hr max flow
-F 100-A001	C-001	13	<del>-</del>	13	STRMUBUID	225,140	225,140	1.00	\$31,700	1997	\$31,700	0,0	\$31,700	1.54	\$49,832 \$ 837,560		14° dia. 100′ long
I-P100-A501	D-501	sum 1	sum	total Beer Column	DIAMD501	4	2.29	0.56	\$636,976	1996	\$636,976	0.70	\$402,792	avg.	sum \$873,434	avg. (installed)	76° DIA, 32 ACTUAL TRAYS, NUTTER V-GRID TRAYS
P100-A502	D-502	1	0	Rectification Column	S510S521	56,477	26,744	0,47	\$525,800	1996	\$525,800	0.78		2.10	\$636,421		8' dia.(rect)., 4' dia. (strip) x 18" T.S., 60 act. Trays, 60% eff., Nutter V-Grid trays
-P100-A504	E-501	1	0	1st Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,676	1996	\$435,676	0.68		2.10	\$944,742		22278 sf each., 135 BTU/hr sf F
-P100-A504	E-502	1	0	2nd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.10	\$944,685	\$449,850	22278 sf., 170 BTU/hr sf F
-P100-A504	E-503	1	0	3rd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.10	\$944,685		22278 sf each., 170 BTU/hr sf F
		5	0	5										2.10	\$ 4,343,968	\$ 868,794	
		sum	sum	total										avg.	sum	avg. (installed)	
-P100-A302	F-300	4	0	Fermentors	GALLONS	750,000	750,000	1.00	\$326,203	1999	\$1,304,812		\$1,304,812	1.76	\$2,297,260		750,000 gal. each, 2 day residence total, 90% wv, API, atmospheric, 50' f x 51'
-P100-A301	F-301	2	0	1st Fermentation Seed Fermentor	None		0	0.45	\$14,700	1997	\$29,400	0.93		2.80	\$39,948		9 gal, jacketed, agitated, 1' dia., 1.5' high, 15 psig
-P100-A301	F-302	2	0	2nd Fermentation Seed Fermentor	None		0	0.45	\$32,600	1997	\$65,200	0.93		2.80	\$88,592		90 gal., jacketed, agitated, 2' 3" dia., 3' high, 2.5 psig
-P100-A301	F-303	2	0	3rd Fermentation Seed Fermentor	None		0	0.45	\$81,100	1997	\$162,200	0.93		2.80	\$220,394		900 gal., jacketed, agitated, 5' dia, 6.5' high, 2.5 psig
-P100-A301 -P100-A301	F-304 F-305	2	0	4th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$39,500	1997	\$79,000	0.93		1,68	\$60,174		9000 gal., 9' dia x 19' high, atmospheric
-P 100-A301	F-305	2	0	5th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$147,245	1998	\$294,490	0.51	\$189,107	1.76	\$336,910	\$191,360	90000 gal., API, atmospheric 25'f x 25'
-P100-A402 -P100-A401	F-400 F-401	11	0	Cellulase Fermentors	GALLONS STRM0433	88,335	88,335	1.00	\$179,952	1998	\$1,979,472	0.7		1.76	\$3,526,602	\$2,003,061	
-P100-A401	F-401	3	<u>U</u>	2nd Cellulase Seed Fermentor	STRM0433	2,790 2,790	932	0.33	\$22,500	1997	\$67,500	0.93		2.00	\$49,648		11 gal / 15 psig / Jacketed / Agitator
-P100-A401	F-402	3	0	3rd Cellulase Seed Fermentor	STRM0433	2,790	932 932	0.33	\$54,100 \$282,100	1997 1997	\$162,300	0.93		2.00	\$119,377 \$622,482		221 gal / 15 psig / Jacketed / Agitator
. 100 / 1.01	, - 400	34	0	34	01KW0433	2,130	334	ບ.ລວ	\$202,100	1997	\$846,300	0.93	\$305,207	2.00			4417 gal / 15 pstg / Jacketed / Agitator
		sum		lotai							<del>'</del>		<del></del> ,	avg,	\$ 7,361,387	avg. (installed)	
			30,,,		•									avy,	Suiir	ery, (mstaned)	

						Scaling			Original		Total Original					Scaled	
D	Equip No.	No. Req'd	No. Spare	Equip Name	Scaling Stream	Stream Flow (Kg/hr)	New Stream Flow	Size Ratio	Equip Cost (per unit)	Base Year	Equip Cost (Reg'd & Spare)		Scaled Cost in Base Year		Installed Cost	Uninstalled Cost in 1999\$	Description
D-P100-A202	H-200	1	0	Hydrolyzate Cooler	AREA0200	1,988	895	0.45	\$45,000	1997	\$45,000	0.51	\$29,947	2.18	\$66,543	\$30,539	Fixed Tube Sheet, 900 st, 20" dia. X 20' long
D-P100-A201	H-201	1	1	Beer Column Feed Economizer	AREA0201	5,641	5,641	1.00	\$139,350	1999	\$278,700	0.68	\$278,700	2.18	\$607,278	\$278,700	TEMA type AES shell and tube 5641 sf, 42" dia x 20' long
D-P100-A302	H-300	4	1	Fermentation Cooler	QHX300EA	67,820	25,053	0.37	\$4,000	1997	\$20,000	0.78	\$9,198	2.18	\$20,438	\$9,380	4 exchangers at 221 sf, U=300 BTU/hr sf F LMTD = 22.9°F plate and frame
D-P100-A301	H-301	- 1	0	Fermentation Seed Hydrolyzate Cooler	AREA0301	773	318	0.41	\$15,539	1998	\$15,539	0.78	\$7,778	2.18	<b>\$</b> 17,151	\$7,871	348 sf, 300 BTU/hr sf F
D-P100-A302	H-302	1	0	Fermentation Pre-Cooler	AREA0302	3,765	828	0.22	\$25,409	1998	\$25,409	0.78	\$7,797	2.18	\$17,193	\$7,890	828 sf total, plate and frame
D-P100-A301	H-304	1	0	4TH Seed Fermentor Coils	QSDF0301	38,339	15,789	0.41	\$3,300	1997	\$3,300	0.B3	\$1,580	1.20	\$1,934	\$1,611	12 sf, 1" sch 40 pipe, 105 BTU/hr sf F
D-P100-A301	H-305	1	0	5TH Seed Fermentor Coils	QSDF0301	38,339	15,789	0.41	\$18,800	1997	\$18,800	0.98	\$7,881	1.20	\$9,644	\$8,037	138 sf, 2" sch 40 pipe, 92 BTU/hr sf F
D-P100-A307	H-307	12	0	Enzymatic Hydrolysis Tank Heater	STRM03028	157,136	157,136	1,00	\$15,000	1999	\$180,000	0.78	\$180,000	2.18	\$392,214	\$180,000	65 ft2 double pipe
D-P100-A307	H-308	1	0	Pre-hydrolyzate cooler	STRM0302	145,536	145,536	1.00	\$25,000	1999	\$25,000	0.78	\$25,000	2.18	\$54,474	\$25,000	481 ft2, parallel double pipe
D-P100-A402	H-400	11	0	Cellulase Fermentation Cooler	QHX400EA	236,668	88,335	0.37	\$34,400	1997	\$378,400	0.78	\$175,431	2.18	\$389,815	\$178,899	Immersible Coil 205 ft2 each
D-P100-A501	H-501	1	0	Beer Column Reboiler	QRFD0501	-7,863,670	-3,723,722	0.474	\$158,374	1996	\$158,374	0.68	\$95,263	2.18	\$214,340	\$98,368	Fixed TS, 6602 st, 31" dia., 20' long, 178 BTU/hr st F
D-P100-A502	H-502	1	0	Rectification Column Reboiler	QRFD0502	-987,427	-467,581	0.474	\$29,600	1997	\$29,600	0.68	\$17,805	2.18	\$39,563	\$18,157	Thermosyphon, 512 sf, 15" dia., 20' long, 130 BTU/hr sf F
D-P100-A501	H-504	1	0	Beer Column Condenser	QCND0501	277,820	131,557	0.474	\$29,544	1996	\$29,544	0.68	\$17,771	2.18	\$39,984	\$18,350	Floating Head, 418 sf, 15" dia., 22' long, 92 BTU/hr sf F
D-P100-A502	H-505	1	0	Rectification Column Condenser	QCND0502	4,905,410	2,322,883	0.474	\$86,174	1996	\$86,174	0.68	\$51,834	2.18	\$116,626	\$53,524	Fixed TS, 1969 st, 29" dia, 20' long, 157 BTU/hr st F
D-P100-A501	H-512	1	1	Beer Column Feed Interchange	AREA0512	909	430	0.474	\$19,040	1996	\$38,080	0.68	\$22,905	2.18	\$51,537		431 sf, 200 BTU/hr sf F
D-P100-A504	H-517	1	1	Evaporator Condenser	QHET0517	6,764,222	3,203,095	0.47	\$121,576	1996	\$243,152	0.68	\$146,257	2.18	\$329,077	\$151,024	Fixed TS, 3906 sf, 29" dia., 20' long, 220 BTU/hr sf F
		40	4	44							·			2.06	\$ 2,367,812	\$ 53,814	
		sum	sum	total										avg.	sum	avg. (installed)	

D-P100-A101	M-101	2	0	Truck Scale	AREA0100	96	72	0.75	\$10,000	1999	\$20,000	0.6	\$16,829	1.50 1.00	\$25,244 \$		96 deliveries /scale/12hr
D-P100-A101	M-102	1	0	Receiving Pad	AREA0100	250,000	250,000	1.00	\$2,083,500	1999	\$2,083,500	0.6	\$2,083,500	1.00	\$2,083,500 \$	2,083,500	250,000 ft2 concrete pad, 9" thick with drainage
D-P100-A101	M-103	6	1	Front End Loader	AREA0100	159,948	159,948	1.00	\$156,000	1998	\$1,092,000	0.6	\$1,092,000	1.20 \$	1,326,016 \$	1,105,013	run on gasoline
D-P100-A101	M-104	3	0	Bale Breaker	AREA0100	154	170	1.11	\$250,000	1999	\$750,000	0.6	\$796,352	1.20	\$955,622 \$	796,352	30 HP each
D-P100-A101	M-105	1	0	Primary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.20	\$135,444 \$	112,870	250 HP, 1200 rpm, hammermill
D-P100-A101	M-106	1	0	Secondary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.50	\$169,304 \$	112,870	250 HP, 1200 rpm, hammermill
D-P100-A101	M-107	1	0	Shred Bunker	AREA0100	600,000	600,000	1.00	\$700,000	1999	\$700,000	0.6	\$700,000	1.00	\$700,000 \$	700,000	200x100x30ft bunker with three walls, 3 days shred storage
D-P100-A101	M-10B	1	0	Storm Runoff Pond	AREA0100	1,747,767	1,747,767	1.00	\$51,198	1998	\$51,198	0.6	\$51,198	1.00	\$51,198 \$	51,808	200 x 150 x 8 ft, 240,000ft3
D-P100-A201	M-202	1	0	Prehydrolysis Reactor	STRM0217	270,034	121,514	0.45	\$12,461,841	1998	\$12,461,841	0.78	\$6,684,746	1.50	\$10,146,612	\$6,764,408	Vertical Screw, 10 min residence time
D-P100-A402	M-401	5	1	Fermentor Air Compressor Package	STRM0440	80,455	80,455	1.00	\$229,000	1999	\$1,374,000	0.34	\$1,374,000	1.30	\$1,786,200	\$1,374,000	7946 sclm each, 50 psig outlet, 1277 hp each, includes starter
																	Superheater, twin mole sieve columns, product cooler, condenser, pumps,
D-P100-A503	M-503	1	0	Molecular Sieve (9 pieces)	STRM0515	20,491	9,703	0.47	\$2,700,000	1998	\$2,700,000	0.7	\$1,599,964	1.00	\$1,619,030	\$1,619,030	vacuum source.
D-P100-A601	M-613	1	0	Syrup Sprayer	STRM0531	22,372	22,372	1.00	\$1,000	1999	\$1,000	0.3	\$1,000	1.20	\$1,200	\$1.000	100 GPM syrup sprayer
D-P100-A601	M-614	1	0	Lignin Loadout	STRM0601A	63,778	0	0.00	\$41,200	1999	\$41,200	0.3	\$0	1,00	\$0		245 GPM @ 20.6% insoluble solids
·	1						·		1		1.1,2						no less than 500,000 gal., above-ground bolted tank with cover, including
D-P100-A602	M-615	٠,	ο	Equalization Basin	STRM0830	98.267	102.204	1.04	\$350.000	1999	\$350,000	0.79	<b>\$</b> 361.031	1.00	<b>\$</b> 361.031	\$261.021	from less than 500,000 gail, above-ground boiled tank with cover, including
D-1 100-A002	14(010		<b>-</b>	Eddanzanoti Dasiti	31(100000	30,207	102,204	1,04	\$330,000	1393	\$330,000	0.75	3301,031	1.00	3301,031	3301,03	Touridations, pumps and condus
D D400 4000	M-616			l													
D-P100-A602	M-919	1	0	Anaerobic Digestion System	STRM0830	98,267	102,204	1.04	\$3,200,000	1999	\$3,200,000	0.79	\$3,300,852	1.00	\$3,300,852	\$3,300,852	500,000 gal., includes site work, foundations, reactors and ancillary equipment
				1			1						ł	1	į		four-350,000 gal. Sequencing Batch Reactors, 48,000 lbs/day of O2 transfer
	1			Î			ĺ		i l				ł	I			capability, de-nitrification facilities, aeration and mixing requires approximately
D-P100-A602	M-617	. 1	0	Aerobic Digestion System	STRM0830	98,267	102,204	1.04	\$4,300,000	1999	\$4,300,000	0.79	\$4,435,520	1.00	\$4,435,520	\$4,435,520	1,400 horsepower
	1																400 ft2 of filtration surface area, includes the engineering and legal cost to
D-P100-A602	M-618	1	0	Pressure Sand Filters	STRM0830	98,267	102,204	1.04	\$280,000	1999	\$280,000	0.79	\$288,825	1.00	\$288,825	\$288,825	acquire an NPDES permit
					STRM0815 +												200,000 #/hr running @ 171,488 #/hr; with 40,000 #/hr 160o superheat;
D-P100-A801	M-803	1	0	Boiler with Superheater	216	200,000	200,000	1.00	\$1,590,000	1999	\$1,590,000	0.7	\$1,590,000	1,30	\$2,067,000	\$1.590.000	132,000#/hr 390o sat, @ 205 psig
D-P100-A802	M-820	1	0	Hot process water softener system	STRM0811B	229,386	45 003	0.20	\$1,383,300	1999	\$1,383,300	0.6	\$520,623	1,20	\$624,748	\$520,623	l
D-P100-A803	M-830			Hydrazine Addition Pkg.	STRM813A	229,386	80.536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1.00	\$10,857		75 gal tank, aditator, 2 metering pumps
D-P100-A803	M-832	1	- 0	Ammonia Addition Pkg	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1,00	\$10.857		75 gal tank, agitator, 2 metering pumps
D-P100-A803	M-834	<u> </u>	<u> </u>	Phosphate Addition Pkg.	STRM813A	229.386	80.536	0,35	\$19,000	1994	\$19,000	0.6	\$10,139	1.00	\$10,857		75 gal tank, agitator, 2 metering pumps
D-P100-A901	M-902	<del>i</del>		Cooling Tower System	QCWCAPIT	41,100,000	12,955,985	0.32		1998	\$1,659,000	0.78	\$674,181	1.20	\$818,659		40,000 gpm, 185.4MM BTU/hr
D-P100-A901	M-904	1	0	Plant Air Compressor	STRM0101	159,950	159,950	1.00	\$60,100	1997	\$60,100	0.74	\$60,100	1,30	\$79,675		450 cfm, 125 psig outlet
D-P100-A901	M-908	1	0	Chilled Water Package	QCHLWCAP	5,040,000	2,268,000	0.45	\$380,000	1997	\$380,000	0.8	\$200,610	1.20	\$245,492		1000 ton, 600kW
D-P100-A903	M-910	1	- ř	CIP System	STRM0914	63	28	0.45	\$95,000	1995	\$95,000	0.6	\$58,837	1.20	\$73.021		designed by Delta-T. (est 0.2 kW)
D 1 100-A303	141.910	38	<del>z</del>	40	1 211/00914	1 03	40	0,40	\$35,000	1995	\$95,000	0.01	\$30,0371	1.15 \$		783,169	Idealdited by Detra. L' Icar or y xxx)
		0		70										1.10 3	31,326,762 \$	183,169	

sum sum total avg. avg. (installed)

D	Equip No.	No. Req'd	No. Spare	Equip Name	Scaling Stream	Scaling Stream Flow (Kg/hr)	New Stream Flow	Size Ratio	Original Equip Cost (per unit)	Base Year	Total Original Equip Cost (Req'd & Spare)		Scaled Cost in Base Year	Instal. Factor	Installed Cost	Scaled Uninstalled Cost in 1999\$	Description
D-P100-A201	P-201	1		Sulfuric Acid Pump	STRM0710	1,647	414	0.25	\$4,800	1997	\$9,600	0.79	\$3,228	2.79	\$9,190	\$3,291	2 gpm, 245 ft. head
D-P100-A203	P-209	. 1	1	Overlimed Hydrolyzate Pump	STRM0228	167,050	102,608	0.61	\$10,700	1997	\$21,400	0.79	\$14,561	2.79	\$41,458	\$14,849	448 gpm, 150 ft. head
D-P100-A203	P-222	_!	1	Filtered Hydrolyzate Pump	STRM0230	162,090	101,614	0.63	\$10,800	1997	\$21,600	0.79	\$14,936	2.79	\$42,526	\$15,231	448 gpm, 150 ft head
D-P100-A203	P-223		0	Lime Unloading Blower	STRM0227	547	337	0.62	\$47,600	1998	\$47,600	0.5	\$37,340	1.40	\$52,898		3341 cfm, 6 psi, 10,024 lb/hr
D-P100-A202	P-224 P-225	1	!	Hydrolysis Feed Pump	STRM0250	160,000	167,795	1.05	\$64,934	1999	\$129,868	0.6	\$133,628	1.20	\$160,354		740 gpm, 240 ft head
D-P100-A202 D-P100-A202	P-225 P-226	1		ISEP Elution Pump	STRM0243	52,731	18,005	0.34	\$7,900	1997	\$15,800	0.79	\$6,761	2.79	\$19,249		104 gpm, 150 ft head
D-P100-A202	P-226 P-227	- 1		ISEP Reload Pump	STRM0246	164,080	100,802	0.61	\$8,700	1997	\$17,400	0.79	\$11,841	2.79	\$33,714		445 gpm, 150 ft head
D-P100-A202	P-239			ISEP Hydrolyzate Feed Pump Reacidified Liquor Pump	STRM0221	160,290	98,157	0.61	\$10,700	1997	\$21,400	0.79	\$14,526	2.79	\$41,359		432 gpm, 150 ft head
D-P100-A302	P-300	4	<u>'</u>	Fermentation Recirc Transfer Pump	STRM0239 QHX300EA	167,280 57,737	102,752 55,505	0.61	\$10,800	1997	\$21,600	0.79	\$14,698	2.79	\$41,847		450 gpm, 100 ft head
D-P100-A301	P-301	<del>-</del>	<u>_</u>	Fermentation Seed Transfer Pump	STRM0304	41,777		0.82	\$8,000 \$22,194	1997	\$40,000	0.79	\$34,177	2.79	\$97,307		844 gpm @ 150 ft sized based on heating rate
D-P100-A301	P-302	2		Seed Transfer Pump	STRM0304	41.777	17,529 17,529	0.42	\$54,088	1998 1998	\$44,388 \$108,176	0.7	\$24,168 \$58,898	1.40	\$34,238		280 gpm @ 150 ft head
D-P100-A302	P-306	1		Beer Transfer Pump	STRM0502	381,701	173,737	0.46	\$17,300	1997	\$34,600	0.79	\$18,579	2.79	\$83,440 \$52,899		504 gpm total, 252 gpm each, 100 ft head
D-P100-A307	P-308	8		Hydrolyzer Bottoms Pump	STRM0302B	157,136	157,136	1.00	\$121,690	1999	\$1,095,210		\$1,095,210	1.20	\$1,314,252		790 gpm each, 171 ft head
D-P100-A402	P-400	1		Cellulase Transfer Pump	STRM0420	40.543	11,600	0.29	\$9,300	1997	\$18,600	0.79	\$6,921	2.79	\$1,314,252		3000 GPM each Disc flow pumps, 245ft head 58 GPM / 100 ft, head
D-P100-A401	P-401	1	1	Cellulase Seed Pump	STRM0433	2,790	932	0.33	\$12,105	1998	\$24,210	0.79	\$11,236	1.20	\$13,644		24 gpm / 1 hp
D-P100-A402	P-405	1	1	Media Pump	STRM0416	586	200	0.34	\$8,300	1997	\$16,600	0.79	\$7,104	2.79	\$20,227		24 gpm / 1 np 21 Gpm/100 Ft Head
D-P100-A405	P-420	1	1	Anti-foam Pump	STRM0417	227	79	0.35	\$5,500	1997	\$11,000	0,79	\$4,761	2.79	\$13,555		4 gpm / 75 ft head
D-P100-A501	P-501	1	1	Beer Column Bottoms Pump	P501FLOW	5,053	2,200	0.44	\$42,300	1997	\$84,600	0.79	\$43,861	2.79	\$124.881		2200 gpm, 150 ft head
D-P100-A501	P-503	1		Beer Column Reflux Pump	QCND0501	277,820	131,557	0.47	\$1,357	1998	\$2,714	0.79	\$1,504	2.79	\$4.248		5 gpm, 140 ft head
D-P100-A502	P-504	1	1	Rectification Column Bottoms Pump	STRM0516	31.507	15,530	0.49	\$4,916	1998	\$9,832	0.79	\$5,622	2.79	\$15,884		76 gpm, 158 ft head
D-P100-A502	P-505	1	1	Rectification Column Reflux Pump	QCND0502	4,906,301	2,323,304	0.47	\$4,782	1998	\$9,564	0.79	\$5,299	2.79	\$14.970		207 gpm, 110 ft head
D-P100-A504	P-511	2	1	1st Effect Pump	STRM0525	278,645	133,617	0.48	\$19,700	1997	\$59,100	0.79	\$33,069	2.79	\$94,155		1137 gpm each, 110 ft head
D-P100-A504	P-512	1	1	2nd Effect Pump	STRM0528	91,111	45,390	0.50	\$13,900	1997	\$27,800	0.79	\$16,032	2.79	\$45,646		599 gpm, 110 ft head
D-P100-A504	P-513	2	1	3rd Effect Pump	STRM0531	48,001	23,814	0.50	\$8,000	1997	\$24,000	0.79	\$13,795	2.79	\$39,276		196 gpm each, 110 ft head
D-P100-A504	P-514	1	1	Evaporator Condensate Pump	STRM534A	140,220	69,285	0.49	\$12,300	1997	\$24,600	0.79	\$14,095	2.79	\$40,131		293 gpm, 125 ft head
D-P100-A502	P-515	1	1	Scrubber Bottoms Pump	STRM0551	15,377	7,427	0.48	\$2,793	1998	\$5.586	0.79	\$3,143	2.79	\$8.881		31 gpm, 104 ft head
D-P100-A501	P-517	1		Kill Tank Bottoms Pump	STRM0518	5,053	660	0.13	\$42,300	1997	\$84,600	0.79	\$15,944	2.79	\$48,242		560gpm, 72 ft head
D-P100-A601	P-630	1		Recycle Water Pump	STRM0602	179,446	84,120	0.47	\$10,600	1997	\$21,200	0.79	\$11,652	2.79	\$33,175		370 gpm, 150ft head
D-P100-A701	P-703	1		Sulfuric Acid Pump	STRM0710	1,647	1,912	1.16	\$8,000	1997	\$16,000	0.79	\$18,001	2.79	\$51,253		215 gpm, 150ft head
D-P100-A701	P-707	1		Antifoam Store Pump	STRM0417	227	79	0.35	\$5,700	1997	\$11,400	0.79	\$4,934	2.79	\$14,048		0.5 gpm, 92 ft head
D-P100-A701	P-720	1	1	CSL Pump	STRM0735	2,039	859	0.42	\$8,800	1997	\$17,600	0.79	\$8,889	2.79	\$25,308		182 gpm, 150ft head
D-P100-A802	P-804	2	1	Condensate Pump	STRM811A	249,633	38,798	0.16	\$7,100	1997	\$21,300	0.79	\$4,894	4.60	\$22,958	\$4,991	130 gpm, 150' head
P100-A802	P-824	2		Deaerator Feed Pump	STRM811A	196,000	38,798	0.20	\$9,500	1997	\$28,500	0.79	\$7,927	8.30	\$67,097		180 gpm, 115' head
0-P100-A802	P-826	4		BFW Pump	STRM0813	207,310	80,536	0.39	\$52,501	1998	\$262,505	0.79	\$124,377	1.40	\$176,203	\$125,859	310 gpm, 2740' head
D-P100-A602	P-828	_!_		Blowdown Pump	STRM0821	6,600	2,699	0.41	\$5,100	1997	\$10,200	0.79	\$5,032	6.40	\$32,842		12 gpm, 150' head
D-P100-A803	P-830			Hydrazine Transfer Pump	STRM813A	229,386	80,536	0.35	\$5,500	1997	\$11,000	0.79	\$4,811	6.40	\$31,402		3 gpm, 75' head
D-P100-A901	P-902			Cooling Water Pumps	STRM0940	18,290,000	5,553,791	0.30	\$332,300	1997	\$664,600	0.79	\$259,201	2.79	\$737,993	\$264,326	12300 gpm, 70ft head
D-P100-A902	P-912	1		Make-up Water Pump	STRM0904	244,160	82,445	0.34	\$10,800	1997	\$21,600	0.79	\$9,161	2.79	\$26,084		370 gpm, 75ft head
D-P100-A902	P-914	1		Process Water Circulating Pump	STRM0905	352,710	111,503	0.32	\$11,100	1997	\$22,200	0.79	\$8,938	2.79	\$25,449	\$9,115	745 gpm, 75ft head
-		58		96										2.90	\$ 3,771,987	\$ 39,292	
		sum	sum	totaf										avg.	sum	avg. (installed)	

I:\PROCESS\3442\PFD\Equipa

ם	Equip No.	No. Req'd	No. Spare	Equip Name	Scaling Stream	Scaling Stream Flow (Kg/hr)	New Stream Flow	Size Ratio	Original Equip Cost (per unit)	Base Year	Total Original Equip Cost (Req'd & Spare)		Scaled Cost in Base Year		Installed Cost	Scaled Uninstalled Cost in 1999\$	Description
D-P100-A202	S-202	3	0	Pre-IX Bell Filter Press	SOLD0220	57,000	57,000	1.00	\$200,000	1998	\$600,000	0.39	\$600,000	1.40	\$850,010	\$607,150	Use 3 units for 45% of the flow as recommended by the vendor
D-P100-A202	S-221	1	0	ISEP	STRM0240	210,005	98,157	0.47	\$2,058,000	1997	\$2,058,000	0.33	\$1,601,194	1.20	\$1,959,422	\$1,632,851	10 chambers (39" dia, X 84" high), 4" dia, Valve - Weak Base Resin
D-P100-A203	S-222	1	0	Hydroclone & Rotary Drum Filter	STRM0229	5,195	1,137	0.22	\$165,000	1998	\$165,000	0.39	\$91,224	1.40	\$129,235	\$92,311	Hydrocyclone and Vacuum Filter for 453 gpm
D-P100-A203	S-227	1	0	LimeDust Vent Baghouse	STRM0227	548	337	0.61	\$32,200	1997	\$32,200	1	\$19,778	1.50	\$30,254	\$20,169	3750 cfm, 625 sf, 6 cfm/sf
D-P100-A601	S-601	2	0	Beer Column Bottoms Centrifuge	CENTFLOW	404	300	0.74	\$659,550	1998	\$1,319,100	0.6	\$1,103,371	1.20	\$1,339,824	\$1,116,520	requires 540gpm duty, 2 @ 300 gpm and 410 hp each
D-P100-A901	S-904	1	1	Instrument Air Dryer	STRM0101	159,950	71,977	0.45	\$15,498	1999	\$30,996	0.6	\$19,197	1.30	\$24,956	\$19,197	134 scfm air dryer, -40F Dewpoint
		9	1	10										1.33	\$ 4,333,701	\$ 433,370	
		sum	sum	total										avg.	sum	avg. (installed)	

D-P100-A201	T-201	1	0	Sulfuric Acid Storage	STRM0710	1,647	860	0.52	\$5,760	1996	\$5,760	0.71	\$3,633	1.68	\$6,283	\$3,751	2000 gal., 24 hr. residence time, 90% wv, 5.5ft diam. X 11ft
D-P100-A201	T-203	1	0	Blowdown Tank	STRM0217	270,300	121,514	0.45	\$64,100	1997	\$64,100	0.93	\$30,475	1.68	\$52,061	\$31,078	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig
D-P100-A203	T-209	1	0	Overliming Tank	STRM0228	167,050	102,608	0.61	\$71,000	1997	\$71,000	0.93	\$50,232	1.76	\$90,186		29850 gal., 16' dia. X 32' high, 1 hr. res. time, 90% wv, 15 psig
P100-A203	T-220	1	0	Lime Storage Bin	STRM0227	548	548	1.00	\$69,200	1997	\$69,200	0.46	\$69,200	1.76	\$124,243	\$70,568	4455 cf, 14' dia x 25' high, 1.5x rail car vol., atmospheric, 15 day storage max
P100-A203	T-224	1	0	Reacidification Tank	STRM0239	102,752	102,752	1.00	\$111,889	1999	\$111,889	0.51	\$111,889	1.76	\$196,992		120,000 gal., 28' dia x 28' high, 4 hr. res. time, 90% wv, atmospheric
P100-A202	T-232	1	0	Slurrying Tank	STRM0250	358,810	167,795	0.47	\$44,800	1997	\$44,800	0.71.	\$26,117	1.76	\$45,890		11300 gal., 13' dia. X 25' high, 15 min. res. time, 90% wv
P100-A301	T-301	1	0	Fermentation Seed Hold Tank	STRM0304	41,777	17,529	0.42	\$161,593	1998	\$161,593	0.51	\$103,767	1.76	\$184,870	\$105.003	105000 gal., API atmospheric
D-P100-A302	T-306	1	0	Beer Weil	STRM0502	129,000	183,467	1.42	\$111,889	1999	\$111,889	0.51	\$133,906	1.76	\$235,756	\$133,966	192,518 gal., 32' dia x 32' high, 4 hr. res. time, 95% wv, atmospheric
																	375,000 gallons, 24 hour residence time, 2 side mounted agitators cone bottom,
D-P100-A307	T-307	4	. 0	Enzymatic Hydrolysis Tank	STRM0302B	750,000	375,000	0.50	\$326,203	1999	\$1,304,812	0.6	\$860,855	2.04	\$1,753,728		concrete base, bottom outlet through the concrete, 30o cone bottom
P100-A302	T-405	1	0	Media-Prep Tank	STRM0416	586	200	0.34	\$64,600	1997	\$64,600	0.71	\$30,128	1.68	\$51,467	\$30,723	2083 Gal / 1.17 hp Agitator
3-P100-A402	T-420	1	0	Anti-foam Tank	STRM0417	227	79	0.35	\$402	1998	\$402	0.71	\$189	1.68	\$321	\$192	67 gal, 3 hr. residence time
P100-A501	T-503	1	0	Beer Column Relfux Drum	QCND0501	277,820	131,557	0.47	\$11,900	1997	\$11,900	0.93	\$5,938	1.68	\$10,144	\$6,055	164 gal, 15 min res. Time, 50% wv, 2'6" dia., 5' long, 25 psig
D-P100-A502	T-505	1	0	Rectification Column Reflux Drum	QCND0502	4,906,301	2,323,304	0.47	\$45,600	1997	\$45,600	0.72	\$26,621	1.68	\$45,476	\$27,147	6225 gal, 15 min res time, 50% wv, 7' dia, 22' long, 25 psig
P100-A502	T-512	1	0	Vent Scrubber	STRM0523	18,523	9,788	0.53	\$99,000	1998	\$99,000	0.78	\$60,197	1.68	\$102,043	\$60,915	5' dia x 25' high, 4 stages, plastic Jaeger Tri-Packing
P100-A501	T-513	1	0	Kill Tank	STRM0518	149,897	149,897	1.00	\$99,920	1999	\$99,920	0.78	\$99,920	1.68	\$167,384	\$99,920	18 psig, 30 mln, res. time
-P100-A601	T-630	t	0	Recycled Water Tank	STRM0602	179,446	84,120	0.47	\$14,515	1998	\$14,515	0.745	\$8,254	1.68	\$13,992	\$8,353	7410 gal, 20 min. res., 2.5 psig, 9.5ft diam. x 14.25ft
-P100-A701	T-703	1	0	Sulfuric Acid Storage Tank	STRM0710	1,647	1,912	1.16	\$42,500	1997	\$42,500	0.51	\$45,860	1.76	\$82,338		20,000 gal, 240 hr supply, 90% wv, 12ft diam. x 24 ft, atmospheric
-P100-A701	T-707	1	0	Antifoam Storage Tank	STRM0417	227	227	1.00	\$14,400	1997	\$14,400	0.71	\$14,400	1,68	\$24,600	\$14,685	12,000 gal, 27 day supply, 10.5ft diam. X 18.5ft
-P100-A701	T-720	1	0	CSL Storage Tank	STRM0735	2,039	859	0.42	\$88,100	1997	\$88,100	0.79	\$44,495	1.68	\$76,011	\$45,375	30160 gal, 90% wv, 120 supply, 14.3ft diam. X 25 ft
-P100-A802	T-804	1	0	Condensate Collection Tank	STRM811A	229,386	38,798	0.17	\$7,100	1997	<b>\$</b> 7,100	0.71	\$2,011	3,30	\$6,766	\$2,050	200 gał, 1.5 min. res. time
-P100-A802	T-824	1	0	Condensate Surge Drum	STRM811A	150,000	38,798	0.26	\$49,600	1997	\$49,600	0.72	\$18,734	5.00	\$95,523	\$19,105	2100 gal., 6' diam. X 10', 15 psig, res. time 11 min.
-P100-A802	T-826	1	0	Deaerator	STRM0813	267,000	80,536	0.30	\$165,000	1998	\$165,000	0.72	\$69,616	6.50	\$457,896	\$70,446	3030 gal., 15 psig, 10 min. res.
-P100-A802	T-828	1	0	Blowdown Flash Drum	STRM0821	6,550	2,699	0.41	\$9,200	1997	\$9,200	0.72	\$4,859	7.30	\$36,168	\$4,955	210 gal., 2.5' diam. X 6', 50 psig 17 min. res.
-P100-A803	T-830	1	0	Hydrazine Drum	STRM813A	229,386	80,536	0.35	\$12,400	1997	\$12,400	0.93	\$4,685	7.00	\$33,440		138 gal, 3.75' x 1.25' diam., 10 psig
-P100-A901	T-904	t	0	Plant Air Receiver	STRM0101	159,950	53,316	0.33	\$13,000	1997	\$13,000	0.72	\$5,894	1.68	. \$10,069		300 gal., 200 psig
P100-A902	T-914	1	0	Process Water Tank	STRM0905	352,710	111,503	0.32	\$195,500	1997	\$195,500	0.51	\$108,663	1.76	\$195,095		234360 gal, 8hr res. time
		29	0	29										2.51	\$ 4,099,742	141,370	
		sum	sum	iotal										avg.	Eum .	avg. (installed)	

TOTAL TAG ITEMS: 155 TOTAL PIECES: 310

I:\PROCESS\3442\PFD\Equipa

## PHOENIX BIO-SYSTEMS, INC.

at ICM. Inc.:

310 North First Street, P.O. Box 397 Colwich, Kansas 67030 Phone: 316-796-0900 Fax: 316-796-0092

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NREL Corn Stover to Ethanol – High Plains Fuel Ethanol Addition – Wastewater – Revision

#### Wastewater Analysis - 98,000 kg/hr total Flow

The attached mass balance estimate describes the proposed wastewater from corn stover processing at the High Plains Plant in York, NE. The overall wastewater, originally described by Merrick Engineering, has been further divided into components as they relate to biological digestion in an anaerobic wastewater treatment system. The stream given by Merrick is the sum of streams 520-Flash to WW Treatment, 247-IX to WW Treatment, 535- to WW Treatment and feedstock receiving pad run-off.

#### Fate of Components

There are several areas worthy of consideration in the analysis. The main organic components of this stream are ammonium acetate, acetic acid, ethanol, furfural and HMF. It has been assumed for the purposes of this analysis that these are all amenable to anaerobic digestion to some extent. The acetate and ethanol components are assumed to be 98 percent removable, while furfural and HMF are assumed to be 80 percent removable. The Corn Steep Liquor is assumed to be 92 percent removable as well.

Aerobic removals of residuals after anaerobic digestion are considered to be better, averaging 98%. Anaerobic digestion is chosen as the least cost method for removal of the largest components of organic COD.

All of the organic components have been expressed as their equivalent Chemical Oxygen Demand (COD) for complete conversion to carbon dioxide and water. Furthermore, values have been converted to pounds per day, which gives the average American reader a better "feel" for the amounts derived. It can be seen that the organic components alone generate approximately 72,000 pounds per day of COD for anaerobic digestion,

This amount of COD also generates some 437,000 cubic feet per day of biogas.

### Sulfate

There is a very significant amount of sulfate included in this stream, due primarily to the need for sulfuric acid regeneration of IX resin used for the removal of Acetic Acid from the Hydrolysis-Fermentation stream. If all of the sulfate were to be converted to hydrogen sulfide in anaerobic digestion, then some 5.699 pounds per day of hydrogen sulfide would be produced. That is the equivalent of 138,000 ppm v/v in the biogas. However, in practice, anaerobic digesters fed very high sulfate streams appear to be self-limiting in hydrogen sulfide production. Hydrogen sulfide in biogas rarely exceeds 5,000 ppm v/v. For the purposes of this analysis, it was assumed that no more than 5,000 ppm v/v H2S would actually occur in the biogas. Therefore only a small

percentage of the available sulfate from ammonium sulfate was theoretically converted to H2S. The remainder is carried through the process as the salt of ammonia.

#### Ammonia Nitrogen

Ammonia is also very high in this waste stream, also due to the IX process regeneration. The hydrolysis of ammonium acetate in the digester results in over 9,300 pounds per day of Ammonia-Nitrogen which, when considered as COD, demands over 40,000 pounds per day of oxygen for conversion to nitrate. Anaerobic digestion will not remove this ammonia nitrogen but will pass it through the reactor in solution.

Among the options for treating this residual ammonia are air stripping and nitrification. Air stripping may be accomplished either during anaerobic digestion or afterward. It should be noted that 9,300 pounds per day of ammonia is likely to be a significant source of air emissions (4.6 tons per day of ammonia is equal to over 1,500 tons per year).

Nitrification is likely to be a more practical treatment, however, it will require some 40,000 pounds per day of oxygen for conversion to nitrate.

#### **Secondary Treatment**

Secondary aerobic treatment will be required in order to address both the residual ammonia and some 8,000 pounds per day of residual organics from the anaerobic digester.

## Existing Capacity at High Plains - York

The existing waste water treatment plant at the High Plains Plant consists of a Bio-Methanation Anaerobic digester, a 2.6 million gallon aerobic lagoon with return activated sludge capability and 400 horsepower aeration, a sludge clarifier, and a sludge holding and aeration pond.

Wastewater is currently pre-treated in this system for discharge to the City of York. It is expected that the City of York might be capable of managing the hydraulic load from the corn stover process, but will impose stringent limits on COD, TSS, and Ammonia Nitrogen.

The existing anaerobic system at York is capable of 18,000 pounds per day of COD removal. Currently, the plant at York utilizes 50 to 75% of this capacity. Therefore, it will be necessary to add significant anaerobic pre-treatment for the corn stover process. Approximately 500,000 gallons of anaerobic digestion capacity will be required.

Although the existing aerobic system may be capable of treating a portion of the anaerobic effluent from the corn stover waste water, significant additional aerobic capacity will be required. The equivalent of at least 40,000 pounds per day of COD removal would be prudent. Furthermore, clarification and sludge management facilities would also require expansion.

## **Estimated Expansion Requirements**

An equalization basin will be required with capacity no less than 300,000 gallons. An above-ground bolted tank with a cover, including foundations, pumps and controls is estimated to cost **\$0.35 million**. The equalization basin is sized to accommodate approximately one half day flow. Flow would proceed from equalization to the anaerobic system.

Anaerobic digestion will require 500,000 gallons of additional capacity. Estimated cost of expansion is **\$3.2 million**, including site work, foundations, reactors and ancillary equipment.

Expansion of aerobic facilities can be accomplished with the addition of four 350,000 gallon Sequencing Batch Reactors, with a capacity of 48,000 pounds per day of oxygen transfer, along with de-nitrification capability. Aeration and mixing would require approximately 1,400 horsepower. Estimated cost for the aerobic section of the expanded plant is \$4.3 million.

Expansion of clarification facilities would not be required as Sequencing Batch Reactors also act as clarifiers during the "Settling Phase".

The City of York is unlikely to accommodate wastewater with nitrate concentrations approximating 2,870 mg/l, therefore, de-nitrification capability would be required. Residual ammonia totals over 9,570 ppd or 835 mg/l, and when converted to nitrate, will be over 2,870 mg/l (32,920 ppd). Conventional means of de-nitrification, such as single or double sludge de-nitrification are likely not adequate for this task, however, Sequencing Batch Reactors have inherent de-nitrification capability. Inclusion of an "anoxic" phase in the Batch sequence converts nitrate to nitrogen gas.

Final filtration through pressure sand filters is recommended. Pressure Sand Filters with 200 square feet of filtration surface area would suffice. This system would consist of 4 x 8'd pressure sand filters, stainless steel construction, with auto-backwash, in a small building. The estimated cost for this system is **\$0.28 million**.

Summarizing capital costs;

- Equalization, one 300,000 gal eq. Tank- \$ 0.35 M
- Anaerobic System, as above- \$3.2 M
- Aerobic SBR's 4 x 350,000 gal \$4.3 M
- Filters- 200 sq. ft. \$0.28 M

Total cost of capital improvements without NPDES discharge is estimated to be \$8.13 million.

The current PFD for the corn stover operation calls for the recycling of wastewater to process use. This is feasible provided that there is sufficient water removed from the process to provide adequate desalting of the total process water. Final sand filtration is recommended for this case. There will be approximately 4,400 mg/l of inorganic salts in the recycle water. This concentration, approaching 0.5% brine could be problematic for re-use. With 50% dilution from fresh water the risk of salting the process is reduced considerably.

In the event that the wastewater cannot be re-used, the city of York may not accommodate the hydraulic flow (622,000 gpd) created by the corn stover process. Current hydraulic flow from existing facility averages over 350,000 gpd, including cooling tower blow-down. An NPDES permit may be required for direct discharge of the additional wastewater.

With NPDES discharge of wastewater capital cost is likely to rise for the cost of out-fall, monitoring stations and additional engineering/legal expenses. Operating costs would also increase due to increased monitoring.

#### ADDENDUM (10-19-99)

## Reduced Hydraulic Flow

Closer review of the various streams comprising the wastewater stream for this project indicates that there will be significantly less wastewater volume than originally believed. Current mass

balance for the processing facility indicates an average flow of 98,267 kg/hr versus the original flow of 217,300 kg/hr. The difference is apparently due to an overestimate of run-off from the feedstock delivery pad during storm events. Correction of this estimate and leveling of storm water flow to the wastewater treatment system results in a much lower total flow.

Unfortunately, the reduced hydraulic load has little impact on the size requirements of both the anaerobic and aerobic treatment units. The reason for this is that all of the organic and nitrogenous wastes are carried by the other plant streams.

The equalization basin and the aerobic SBR system can be reduced in size in accord with the lower hydraulic flow. The information given above is valid for the reduced flow case.

#### Removal of IX Treatment

It has been suggested that the Ion Exchange removal of Acetic acid might be eliminated from the proposed process. If research shows this to be possible, the savings in wastewater treatment and chemical costs would be significant.

Although Acetic Acid would still be produced in Stover hydrolysis, if it could be successfully carried through fermentation, it would be removed in the anaerobic reactor. This water could be recycled without the risk of acetate poisoning of the yeast fermentation.

Furthermore, the deletion of IX would eliminate the requirement for the purchase and application of Ammonia for regeneration. This would also remove the requirement for over 40,000 ppd of oxygenation for nitrogen removal in the aerobic wastewater treatment system.

Mass Balance and operating cost estimates have been completed for both of these cases;

- 1- Reduced hydraulic flow to 98,000 kg/hr and
- 2- Elimination of IX treatment for acetic acid removal.

It is obvious that the elimination of IX treatment has very significant economic impact on operating costs for wastewater treatment. The net operating cost of treatment for the reduced flow case (including credit for biogas produced) is \$913,000 per year without depreciation. The net operating cost for treatment without IX is \$122,000 per year. Net savings is \$791,000 per year or 87% of operating costs. The difference is due to reduced operating costs associated with the removal of Ammonia-derived nitrogen from the wastewater.

In addition, capital costs will be lower due to the need for much less aerobic capacity. The aerobic section of wastewater treatment can be reduced from  $4 \times 350,000$  gal SBR's to  $2 \times 180,000$  gal SBR's. Aeration systems will be reduced as well. Capital cost for the reduced aerobic SBR system is estimated at \$1.73 M. Capital for all components of this system would be;

- Equalization, one 200,000 gal eq. Tank- \$ 0.295 M
- Anaerobic System, as above- \$3.2 M
- Aerobic SBR's \$1.23 M
- Filters- 150 sq. ft. **\$0.245 M**

The total capital for this complete system would be \$4.97 M, which is a capital savings of 39%.

Some Caustic has been included in the operating costs for this case since ammonia nitrogen is no longer in high concentration. In the earlier case no caustic was required due to the presence of large amounts of ammonia.

In addition, sulfate is no longer a problem as the elimination of IX and associated sulfuric acid has reduced available sulfate to what would be derived from feedstock and make-up fresh water. It is expected that Hydrogen sulfide would not exceed 500 ppm in the biogas, which is easily removed with low cost scrubbing.

Salt concentration in this treated wastewater would be quite low and would pose no significant risk for re-use.

This system would be capable of:

- a- Producing water for discharge to the environment
- b- Producing water for discharge to the City of York without surcharge
- c- Producing water for re-use in the process

#### Cooling Tower Blow-Down

Cooling tower blow-downs have been deleted from this analysis since these waters do not contain appreciable amounts of pollutants. Generally, cooling tower blow-downs can be released to the environment on NPDES permits, without difficulty.

PARAMETERS         AMOUNTS         DAILY COST         AMOUNTS         DAILY COST           Flow, Gallons Per Minute (GPM)         301.00         301.00         433.440.00         433.440.00           Flow, Gallons Per Day (GPD)         433.440.00         433.440.00         433.440.00           Chemical Oxygen Demand (COD) mg/l         20.000.00         1.080.00         1.080.00           Pounds Per Day COD         72.271.82         6.504.46         6.504.46           Pounds Per Day BOD         50.590.28         4.553.12         4.553.12           Inlet Temperature         30C         30C         30C           Total Nitrogen mg/l         250.00         205.00         740.79           Total Phosphate mg/l         30.00         28.00         740.79           Total Phosphate PD         108.41         101.18         400.70           COD Space Loading Rate g/l/d         18.00         2.00         2.00           COD Space Loading Rate g/l/d         18.00         2.00         2.00           COD Space Loading Rate g/l/d         18.00         2.00         2.00           COD Space Loading Rate g/l/d         18.00         3.00         36.00           Residual COD mg/l         1.400.00         36.00         36.00		ANAER BIO-METH		DISCHARGE WITH SBR AEROBIC TREATMENT			
Flow, Gallons Per Day (GPD)	PARAMETERS	AMOUNTS	DAILY COST	AMOUNTS	DAILY COST		
Chemical Oxygen Demand (COD) mg/l         20,000,00         1,800,00           Biological Oxygen Demand (BOD5) mg/l         12,000,00         1,080,00           Pounds Per Day COD         72,271,82         6,504,46           Pounds Per Day BOD         50,590,28         4,553,12           Inlet Temperature         30C         30C           Total Nitrogen mg/l         250,00         205,00           Total Nitrogen PPD         903,40         740,79           Total Phosphate PPD         108,41         101,18           COD Space Loading Rate g/l/d         18,00         2,00           Residual BOD5 mg/l         40,00         36,00           Residual COD From Space Loading Rate g/l/d <th< th=""><th>Flow, Gallons Per Minute (GPM)</th><th>301.00</th><th></th><th>301.00</th><th></th></th<>	Flow, Gallons Per Minute (GPM)	301.00		301.00			
Chemical Oxygen Demand (COD) mg/l         20,000.00         1,800.00           Biological Oxygen Demand (BOD5) mg/l         12,000.00         1,080.00           Pounds Per Day COD         72,271.82         6,504.46           Pounds Per Day BOD         50,590.28         4,553.12           Inleit Temperature         30C         30C           Total Nitrogen mg/l         250.00         740.79           Total Nitrogen PPD         903.40         740.79           Total Phosphate mg/l         30.00         28.00           Total Phosphate PPD         108.41         101.18           COD Space Loading Rate g/l/d         18.00         2.00           COD Reduction         0.93         0.98           Residual COD mg/l         1,400.00         36.00           Residual COD PPD         5,059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 mg/l         90.00         150.57           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 mg/l         840.00         10.00           TSS mg/l         0.00         67.75           Pummjer         5.00	Flow, Gallons Per Day (GPD)	433,440.00		433,440,00			
Pounds Per Day BOD         72.271 82         6,504.46           Pounds Per Day BOD         50,590.28         4,553.12           Inlet Temperature         30C         30C           Total Nitrogen mg/l         250.00         205.00           Total Nitrogen PPD         903.40         740.79           Total Phosphate mg/l         30.00         28.00           Total Phosphate PPD         108.41         101.18           COD Space Loading Rate g/l/d         18.00         2.00           COD Reduction         0.93         0.98           Residual COD mg/l         1,400.00         36.00           Residual COD PPD         5,059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 pPD         3,035.42         91.06           TSS mg/l         0.00         100.00           TSS PPD         0.00         150.57           Mixing         0.00         67.75           Pumping         34.88         43.34           Total Prosepower         5.00         150.57           Mixing         0.00         67.75           Pumping         34.68         261.67           Cost per kwh         0.035	Chemical Oxygen Demand (COD) mg/l			'			
Pounds Per Day BOD         50.590.28         4,553.12           Inlet Temperature         30C         30C           Total Nitrogen mg/l         250.00         740.79           Total Nitrogen PPD         903.40         740.79           Total Phosphate mg/l         30.00         28.00           Total Phosphate PPD         108.41         101.18           COD Space Loading Rate g/l/d         18.00         2.00           COD Reduction         0.93         0.98           Residual COD mg/l         1,400.00         36.00           Residual COD PPD         5,059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 mg/l         840.00         100.80           Residual BOD5 mg/l         840.00         100.00           TSS mg/l         0.00         100.00           TSS mg/l         0.00         67.75           Blower Horsepower         5.00         150.57           Mixing         0.00         67.75           Pumping         34.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4,647.17         \$162.65      <	Biological Oxygen Demand (BOD5) mg/l	12,000.00		1,080.00			
Pounds Per Day BOD   50,590.28	Pounds Per Day COD	72,271.82		6,504.46			
Inlet Temperature   30C   30C   70tal Nitrogen mg/l   250.00   205.00   205.00   70tal Nitrogen mg/l   250.00   205.00   740.79   70tal Nitrogen PPD   903.40   740.79   70tal Phosphate mg/l   30.00   28.00   70tal Phosphate mg/l   30.00   28.00   70tal Phosphate mg/l   30.00   28.00   70tal Phosphate PPD   108.41   101.18   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00   700.00	Pounds Per Day BOD						
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Total Phosphate mg/l         30.00         28.00           Total PhosphatePPD         108.41         101.18           COD Space Loading Rate g/l/d         18.00         2.00           COD Reduction         0.93         0.98           Residual COD mg/l         1,400.00         36.00           Residual COD PPD         5.059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 PPD         3,035.42         91.06           TSS mg/l         0.00         100.00           TSS PPD         0.00         150.57           Mixing         0.00         67.75           Pumping         34.68         43.34           Total Horsepower         39.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4,647.17         \$162.65           Chemicals Required, Ibs/day:         (65.04)         \$0.00         \$0.00         \$0.00           Phosphate         (65.04)         \$0.00         \$0.00         \$0.00         \$0.00           Phosphate         (65.04)         \$0.00         \$0.00         \$0.00         \$0.00         \$0.00         \$0.00							
Total PhosphatePPD         108.41         101.18           COD Space Loading Rate g/l/d         18.00         2.00           COD Reduction         0.93         0.98           Residual COD mg/l         1,400.00         36.00           Residual COD PPD         5,059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 PPD         3,035.42         91.06           TSS mg/l         0.00         100.00           TSS PPD         0.00         361.36           Horsepower Required:           Blower Horsepower         5.00         150.57           Mixing         0.00         67.75           Pumping         34.68         43.34           Total Horsepower         39.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4.647.17         \$162.65           Chemicals Required, Ibs/day:           Nitrogen         (773.31)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00<							
COD Space Loading Rate g/l/d       18.00       2.00         COD Reduction       0.93       0.98         Residual COD mg/l       1.400.00       36.00         Residual COD PPD       5.059.03       130.09         Residual BOD5 mg/l       840.00       10.80         Residual BOD5 PPD       3.035.42       91.06         TSS mg/l       0.00       100.00         TSS PPD       0.00       150.57         Mixing       0.00       67.75         Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4.647.17       \$162.65         Chemicals Required, Ibs/day:       1       \$2.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$0.00       \$0.00 </th <th>· · · · · · · · · · · · · · · · · · ·</th> <th></th> <th></th> <th></th> <th></th>	· · · · · · · · · · · · · · · · · · ·						
COD Reduction         0.93         0.98           Residual COD mg/l         1.400.00         36.00           Residual COD PPD         5,059.03         130.09           Residual BOD5 mg/l         840.00         10.80           Residual BOD5 PPD         3,035.42         91.06           TSS mg/l         0.00         100.00           TSS PPD         0.00         150.57           Mixing         0.00         67.75           Pumping         34.68         43.34           Total Horsepower         39.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4.647.17         \$162.65           Chemicals Required, Ibs/day:         704.63         \$24.66         4.647.17         \$162.65           Chemicals Required (65.04)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00         \$0.00           Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic Ibs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         \$0.0	•						
Residual COD mg/l							
Residual COD PPD       5,059,03       130,09         Residual BOD5 mg/l       840,00       10.80         Residual BOD5 PPD       3,035,42       91.06         TSS mg/l       0.00       100.00         TSS mg/l       0.00       361.36         Horsepower Required:         Blower Horsepower       5.00       150.57         Mixing       0.00       67.75         Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$0.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00       \$0.00							
Residual BOD5 mg/l       840.00       10.80         Residual BOD5 PPD       3,035.42       91.06         TSS mg/l       0.00       100.00         TSS mg/l       0.00       150.67         Horsepower Required:         Blower Horsepower       5.00       150.57         Mixing       0.00       67.75         Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       \$0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Gaustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$87.50       Chlorine       0.00       \$0.00       \$0.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00       \$0.00       \$0.00 </th <th>_</th> <th></th> <th></th> <th></th> <th></th>	_						
Residual BOD5 PPD       3,035.42       91.06         TSS mg/I       0.00       100.00         TSS PPD       0.00       361.36    Horsepower Required: Blower Horsepower       5.00       150.57 Mixing       0.00       67.75 Pumping       34.68       43.34       Total Horsepower       39.68       261.67       Cost per kwh       0.035       Kwh per day       704.63       \$24.66       4,647.17       \$162.65          Chemicals Required, Ibs/day:       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$35.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00         Sludge (Biomass) Generation:       Dry Weight Yield, Ibs/day       1,445.44       1,951,33.92         Sludge Total Solids       6%       1%							
TSS mg/l 0.00 100.00 TSS PPD 0.00 361.36  Horsepower Required:  Blower Horsepower 5.00 150.57  Mixing 0.00 67.75  Pumping 34.68 43.34  Total Horsepower 39.68 261.67  Cost per kwh 0.035 0.035  Kwh per day 704.63 \$24.66 4,647.17 \$162.65  Chemicals Required, Ibs/day:  Nitrogen (773.31) \$0.00 0.00 \$0.00  Phosphate (65.04) \$0.00 0.00 \$0.00  Micro-Nutrients 7.23 \$3.61 0.00 \$0.00  Caustic Ibs/day Required 328.11 \$49.22 0.00 \$0.00  Polymer @ \$ 2.50/lb 0.00 \$0.00 \$0.00  Sludge (Biomass) Generation:  Dry Weight Yield, Ibs/day 1,445.44 1,951.34  Wet Weight of Sludge, Ibs/day  Sludge Total Solids 6% 1%	——————————————————————————————————————						
TSS PPD 0.00 361.36  Horsepower Required:  Blower Horsepower 5.00 150.57  Mixing 0.00 67.75  Pumping 34.68 43.34  Total Horsepower 39.68 261.67  Cost per kwh 0.035 0.035  Kwh per day 704.63 \$24.66 4.647.17 \$162.65  Chemicals Required, Ibs/day: Nitrogen (773.31) \$0.00 0.00 \$0.00  Phosphate (65.04) \$0.00 0.00 \$0.00  Micro-Nutrients 7.23 \$3.61 0.00 \$0.00  Micro-Nutrients 7.23 \$3.61 0.00 \$0.00  Caustic Ibs/day Required 328.11 \$49.22 0.00 \$0.00  Polymer @ \$ 2.50/lb 0.00 \$0.00 \$0.00  Polymer @ \$ 2.50/lb 0.00 \$0.00 \$0.00  Sludge (Biomass) Generation:  Dry Weight Yield, Ibs/day 1.445.44 1.951.34  Wet Weight of Sludge, Ibs/day 24,090.61 195,133.92  Sludge Total Solids 6% 1%							
Blower Horsepower         5.00         150.57           Mixing         0.00         67.75           Pumping         34.68         43.34           Total Horsepower         39.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4,647.17         \$162.65           Chemicals Required, Ibs/day:           Nitrogen         (773.31)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00         \$0.00           Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic Ibs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         \$5.00         \$87.50           Chlorine         0.00         \$0.00         0.00         \$0.00           Sludge (Biomass) Generation:         Dry Weight Yield, Ibs/day         1,445.44         1,951.34           Wet Weight of Sludge, Ibs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	•						
Mixing       0.00       67.75         Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$5.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00       \$0.00         Sludge (Biomass) Generation:       Dry Weight Yield, Ibs/day       1,445.44       1,951.34       Wet Weight of Sludge, Ibs/day       24,090.61       195,133.92       Sludge Total Solids       6%       1%	Horsepower Required:						
Mixing       0.00       67.75         Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$5.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00         Sludge (Biomass) Generation:       Dry Weight Yield, Ibs/day       1,445.44       1,951.34         Wet Weight of Sludge, Ibs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Blower Horsepower	5.00		150.57			
Pumping       34.68       43.34         Total Horsepower       39.68       261.67         Cost per kwh       0.035       0.035         Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       35.00       \$87.50         Chlorine       0.00       \$0.00       0.00       \$0.00         Sludge (Biomass) Generation:         Dry Weight Yield, Ibs/day       1,445.44       1,951.34         Wet Weight of Sludge, Ibs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Mixing	0.00					
Total Horsepower         39.68         261.67           Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4,647.17         \$162.65           Chemicals Required, Ibs/day:           Nitrogen         (773.31)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00         \$0.00           Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic Ibs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         \$5.00         \$87.50           Chlorine         0.00         \$0.00         \$0.00         \$0.00         \$0.00           Sludge (Biomass) Generation:           Dry Weight Yield, Ibs/day         1,445.44         1,951.34           Wet Weight of Sludge, Ibs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Pumping	34.68					
Cost per kwh         0.035         0.035           Kwh per day         704.63         \$24.66         4,647.17         \$162.65           Chemicals Required, Ibs/day:           Nitrogen         (773.31)         \$0.00         0.00         \$0.00           Phosphate         (65.04)         \$0.00         0.00         \$0.00           Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic Ibs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         35.00         \$87.50           Chlorine         0.00         \$0.00         0.00         \$0.00           Sludge (Biomass) Generation:         Dry Weight Yield, Ibs/day         1,445.44         1,951.34           Wet Weight of Sludge, Ibs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Total Horsepower	39.68					
Kwh per day       704.63       \$24.66       4,647.17       \$162.65         Chemicals Required, Ibs/day:         Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/Ib       0.00       \$0.00       \$35.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00         Sludge (Biomass) Generation:       Dry Weight Yield, Ibs/day       1,445.44       1,951.34         Wet Weight of Sludge, Ibs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Cost per kwh						
Nitrogen       (773.31)       \$0.00       0.00       \$0.00         Phosphate       (65.04)       \$0.00       0.00       \$0.00         Micro-Nutrients       7.23       \$3.61       0.00       \$0.00         Caustic Ibs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       \$5.00       \$87.50         Chlorine       0.00       \$0.00       \$0.00       \$0.00         Sludge (Biomass) Generation:       Dry Weight Yield, Ibs/day       1,445.44       1,951.34         Wet Weight of Sludge, Ibs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Kwh per day	704.63	\$24.66		\$162.65		
Phosphate         (65.04)         \$0.00         0.00         \$0.00           Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic lbs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         \$5.00         \$87.50           Chlorine         0.00         \$0.00         \$0.00         \$0.00           Sludge (Biomass) Generation:         Dry Weight Yield, lbs/day         1,445.44         1,951.34           Wet Weight of Sludge, lbs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Chemicals Required, Ibs/day:						
Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic Ibs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/Ib         0.00         \$0.00         35.00         \$87.50           Chlorine         0.00         \$0.00         0.00         \$0.00           Sludge (Biomass) Generation:         Dry Weight Yield, Ibs/day         1,445.44         1,951.34           Wet Weight of Sludge, Ibs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Nitrogen	(773.31)	\$0.00	0.00	\$0.00		
Micro-Nutrients         7.23         \$3.61         0.00         \$0.00           Caustic lbs/day Required         328.11         \$49.22         0.00         \$0.00           Polymer @ \$ 2.50/lb         0.00         \$0.00         35.00         \$87.50           Chlorine         0.00         \$0.00         0.00         \$0.00           Sludge (Biomass) Generation:           Dry Weight Yield, lbs/day         1,445.44         1,951.34           Wet Weight of Sludge, lbs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Phosphate	(65.04)	\$0.00				
Caustic lbs/day Required       328.11       \$49.22       0.00       \$0.00         Polymer @ \$ 2.50/lb       0.00       \$0.00       35.00       \$87.50         Chlorine       0.00       \$0.00       0.00       \$0.00         Sludge (Biomass) Generation:         Dry Weight Yield, lbs/day       1,445.44       1,951.34         Wet Weight of Sludge, lbs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Micro-Nutrients	7.23					
Polymer @ \$ 2.50/lb       0.00       \$0.00       \$0.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.00       \$50.	Caustic Ibs/day Required	328.11					
Chlorine         0.00         \$0.00         \$0.00         \$0.00           Sludge (Biomass) Generation:           Dry Weight Yield, lbs/day         1,445.44         1,951.34           Wet Weight of Sludge, lbs/day         24,090.61         195,133.92           Sludge Total Solids         6%         1%	Polymer @ \$ 2.50/lb						
Dry Weight Yield, lbs/day       1,445.44       1,951.34         Wet Weight of Sludge, lbs/day       24,090.61       195,133.92         Sludge Total Solids       6%       1%	Chlorine						
Wet Weight of Sludge, Ibs/day 24,090.61 195,133.92 Sludge Total Solids 6% 1%	Sludge (Biomass) Generation:						
Wet Weight of Sludge, Ibs/day 24,090.61 195,133.92 Sludge Total Solids 6% 1%	Dry Weight Yield, lbs/day	1,445.44		1,951.34			
Sludge Total Solids 6% 1%	Wet Weight of Sludge, lbs/day	24,090.61					
AL	Sludge Total Solids	6%					
	Sludge Yield on COD	2%					

PARAMETERS	AMOUNTS	DAILY COST	AMOUNTS	DAILY COST
Sludge Disposal : Dewatering @ \$ 0.XX per 1000 lb wet weight Volume Reduction Disposal Volume-gal	0.00 0% 0.00	\$0.00	0.00 0.00 23,369.33	\$0.00 \$0.00
Disposal @ \$ 0.0X/gal  Bio-Gas Produced (CFD):  Methane Yield (85%) CFD  Less Heating Requirement  Net Methane for energy- CFD	0.00 443,987.25 377,389.16 0.00 377,389.16	\$0.00	0.010 0.00 0.00 0.00 0.00	\$233.69
Bio-Gas Credit (\$2.50/MMBTU Methane)		(\$943.47)	0.00	\$0.00
Labor: Cost per hour (\$) Manhours / Day Maintenance parts	18.00 3.00 50.00	\$54.00 \$60.00	18.00 8.00 50.00	\$144.00 \$60.00
Sewer Surcharge (if applicable): Flow @ \$0.XX /1000 gal	0.00	\$0.00	1.00	\$433.44
Allowable BOD5 Concentration mg/l PPD Allowable BOD5 Residual BOD5 to Sewer PPD	300.00 1,084.08		300.00 1,084.08	
BOD5 Surcharge @ \$x.xx/lb	1,951.34 0.20	\$0.00	(993.01) 0.20	\$0.00
Allowable TSS Concentration mg/l PPD Allowable TSS Residual TSS to Sewer PPD TSS @ \$0.XX /lb	250.00 903.40 0.00 0.00	\$0.00	250.00 903.40 361.36 0.00	\$0.00
Total Daily Cost Annual Cost (Days per year)	330.00	(\$751.98) (\$248,153.43)	330.00	\$1,121.28 \$370,023.84
Daily Operating Cost w/o Methane Credit		\$191.49		\$1,121.28
Annual Operating Cost w/o Methane Credit	330.00	\$63,192.63	330.00	\$433,216.47

## Operating Costs - NREL - Corn Stover Wastewater Model - 98,000 kg/hr to WW

	ANAER	OBIC	DISCHARGE WITH		
	BIO-METH	ANATOR	SBR		
			AEROBIC TREATMENT		
PARAMETERS	AMOUNTS	DAILY COST	AMOUNTS	DAILY COST	
Flow, Gallons Per Minute (GPM)	432.00		432.00		
Flow, Gallons Per Day (GPD)	622,080.00		622,080.00		
Chemical Oxygen Demand (COD) mg/l	13,700.00		9,450.00		
Biological Oxygen Demand (BOD5) mg/l	8,220.00		5,670.00		
Pounds Per Day COD	71,052.09		49,010.38		
Pounds Per Day BOD	49,736.46		34,307.27		
Inlet Temperature	30C		30C		
Total Nitrogen mg/l	2,959.00		2,920.00		
Total Nitrogen PPD	15,346.21		15,143.95		
Total Phosphate mg/l	30.00		28.00		
Total PhosphatePPD	155.59		145.22		
COD Space Loading Rate g/l/d	18.00		4.00		
COD Reduction	0.93		0.98		
Residual COD mg/l	959.00		189.00		
Residual COD PPD	4,973.65		980.21		
Residual BOD5 mg/l	575.40		56.70		
Residual BOD5 PPD	2,984.19		686.15		
TSS mg/l	0.00		100.00		
TSS PPD	0.00		518.63		
Horsepower Required:					
Blower Horsepower	5.00		1,134.50		
Mixing	0.00		204.21		
Pumping	49.77		62.21		
Total Horsepower	54.77		1,400.92		
Cost per kwh	0.035		0.035		
Kwh per day	972.65	\$34.04	24,880.29	\$870.81	
Chemicals Required, lbs/day:					
Nitrogen	(15,218.32)	\$0.00	0.00	\$0.00	
Phosphate	(112.96)	\$0.00	0.00	\$0.00	
Micro-Nutrients	7.11	\$3.55	0.00	\$0.00	
Caustic Ibs/day Required	0.00	\$0.00	0.00	\$0.00	
Polymer @ \$ 2.50/lb	0.00	\$0.00	35.00	\$87.50	
Chlorine	0.00	\$0.00	0.00	\$0.00	
Sludge (Biomass) Generation:					
Dry Weight Yield, lbs/day	1,421.04		14,703.11		
Wet Weight of Sludge, lbs/day	23,684.03		1,470,311.43		
Sludge Total Solids	6%		1%		
Sludge Yield on COD	2%		30%		
			- · ·		

## Operating Costs - NREL - Corn Stover Wastewater Model - 98,000 kg/hr to WW

PARAMETERS	AMOUNTS	DAILY COST	AMOUNTS	DAILY COST
Sludge Disposal :				
Dewatering @ \$ 0.XX per 1000 lb wet weight	0.00	\$0.00	0.00	\$0.00
Volume Reduction	0%	*****	0.00	\$0.00
Disposal Volume-gal	0.00		176,085.20	Ψ0.00
Disposal @ \$ 0.0X/gal	0.00	\$0.00	0.010	\$1,760.85
Bio-Gas Produced (CFD):	436,494.04		0.00	
Methane Yield (85%) CFD	371,019.94		0.00	
Less Heating Requirement	0.00		0.00	
Net Methane for energy- CFD	371,019.94		0.00	
Bio-Gas Credit (\$2.50/MMBTU Methane)		(\$927.55)	0.00	\$0.00
Labor:				
Cost per hour (\$)	18.00		18.00	
Manhours / Day	3.00	\$54.00	8.00	\$144.00
Maintenance parts	50.00	\$60.00	50.00	\$60.00
Sewer Surcharge (if applicable):				
Flow @ \$0.XX /1000 gal	0.00	\$0.00	1.00	\$622.08
Allowable BOD5 Concentration mg/l	300.00		300.00	***************************************
PPD Allowable BOD5	1,555.89		1,555.89	
Residual BOD5 to Sewer PPD	1,428.30		(869.74)	
BOD5 Surcharge @ \$x.xx/lb	0.20	\$0.00	0.20	\$0.00
Allowable TSS Concentration mg/l	250.00		250.00	
PPD Allowable TSS	1,296.57		1,296.57	
Residual TSS to Sewer PPD	0.00		518.63	
TSS @ \$0.XX /lb	0.00	\$0.00	0.00	\$0.00
Total Daily Cost		(\$775.95)		\$3,545.24
Annual Cost ( Days per year)	330.00	(\$256,064.97)	330.00	\$1,169,929.96
Daily Operating Cost w/o Methane Credit		\$151.60		\$3,545.24
Annual Operating Cost w/o Methane Credit	330.00	\$50,026.48	330.00	\$1,219,956.45

#### INCEL Wastewater-Com Stover Case - Mass Balance Estimate - 30,000 kg/m Flow - Willion in

Wastewater Components	Total Wastewater - Kg/hr	Total Wastewater - Lbs/day	Conc - mg/i	Conc as COD - mg/l	COD - Lbs/day	COD for Anaerobic Digestion - Lbs/day	Residual COD - Lbs/day	Other Residuals - Lbs/day	Residuals Conc - as COD - mg/l	After Aerobic & Deni mg/l
Total Flow-	68,635.0	3,623,928.0				3,623,928.0	3,623,928.0			3,623,928.0
Gallons		434,523.7				434,523.7	434,523.7			434,523.7
Insoluble solids (is)	0.0	0.0								
Soluble solids (ss)	1,297.1	68,486.9	18,905.3							
Water	67,337.9	3,555,441.1								
Ethanol	22.0	1,161.6	320.7	352.7	1,277.8	1,277.8	25.6		7.1	0.1
CSL (ss)	33.0	1,742.4	481.0	529.1	1,916.6	1,916.6	153.3		42.3	8.0
(NH4)2SO4 for digestion	0.0	0.0								·
SO4 for conversion from Amm sulfate**	0.0	0.0	0.0						0.0	
NH4 from Amm Sulfate		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Unconverted (NH4)2SO4	0.0	0.0	0.0					0.0		0.0
NH4 from Amm Acetate	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0
Total Acetate C2H4O2	693.1	36,595.7	10,102.0	11,112.2	40,255.2	40,255.2	805.1		222.2	4.4
Furfural	457.0	24,129.6	6,660.8	8,659.0	26,542.6	26,542.6	5,308.5		1,465.4	44.0
HMF	31.0	1,636.8	451.8	587.4	1,800.5	1,800.5	360.1		99.4	3.0
NH4	4.0	211.2	58.3	250.7	908.2		908.2		250.7	7.5
NH4OH***	54.0	2,851.2	787.1					333.0	64.0	1.9
Other	3.0	158.4	43.7	48.1	174.2	174.2	17.4		4.8	2.4
TOTALS			18,905.3	21,539.2	72,875.1	71,966.8	7,578.2	333.0	2,155.9	64.2

Hydogen Sulfide - *

BioGas Production- CFD- 85% CH4

Energy mmbtu/day

.....

* H2S at 5,000 v/v ppm in biogas

0.0

442,113.6 375.8

^{**} SO4 estimated limit of conversion at 5,000 ppm H2S- in biogas

^{***} Expected to be neutral salts in digester

## NREL Wastewater- Corn Stover Case - Mass Balance Estimate - 98,000 kg/hr Flow

Wastewater Components	Total Wastewater - Kg/hr	Total Wastewater - Lbs/day	Conc - mg/l	Conc as COD - mg/l	COD - Lbs/day	COD for Anaerobic Digestion - Lbs/day	Residual COD - Lbs/day	Other Residuals - Lbs/day	Residuals Conc - as COD - mg/l	After Aerobic & Deni mg/l
Total Flow-	98,267.0	5,188,497.6				5,188,497.6	5,188,497.6			5,188,497 6
Gallons		622,122.0				622,122.0	622,122.0			622,122.0
Insoluble solids (is)	0.0	0.0								
Soluble solids (ss)	1,907.0	100,689.6	19,413.3							
Water	96,360.0	5,087,808.0								
Ethanol	22.0	1,161.6	224.0	246.4	1,277.8	1,277.8	25.6		4.9	0.0
CSL (ss)	33.0	1,742.4	335.9	369.5	1,916.6	1,916.6	153.3		29.6	0.6
(NH4)2SO4 for digestion	16.0	844.8								
SO4 for conversion from Amm sulfate**	11.5	607.2	117.1						0.0	
NH4 from Amm Sulfate	4.5	237.6	45.8	197.0	1,021.7		1,021.7	237.6	197.0	5.9
Unconverted (NH4)2SO4	401.0	21,172.8	4,082.2					21,172.8		4,082.2
NH4 from Amm Acetate	176.9	9,340.3	1,800.8	7,743.6	40,163.4		40,163.4	9,340.3	7,743.6	232.3
Total Acetate C2H4O2	693.1	36,595.7	7,055.8	7,761.3	40,255.2	40,255.2	805.1		155.2	3.1
Furfural	457.0	24,129.6	4,652.3	6,047.9	26,542.6	26,542.6	5,308.5		1,023.5	30.7
HMF	31.0	1,636.8	315.6	410.3	1,800.5	1,800.5	360.1		69.4	2.1
NH4	4.0	211.2	40.7	175.1	908.2		908.2		175.1	15.8
NH4OH***	54.0	2,851.2	549.7					549.7	0.0	106.0
Other	3.0	158.4	30.5	33.6	174.2	174.2	17.4		3.4	1.7
TOTALS			19,250.4	22,984.7	114,060.1	71,966.8	48,763.2	31,300.4	9,401.7	4,480.4
Hydogen Sulfide - *								215.3		
BioGas Production- CFD- 85% CH4						442,113.6				

375.8

Energy mmbtu/day

* H2S at 5,000 v/v ppm in biogas

^{**} SO4 estimated limit of conversion at 5,000 ppm H2S- in biogas

^{***} Expected to be neutral salts in digester

# Appendix 7

## **Structure of Appendix 7**

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"Summary of On-sites" - summary of the comparison of the study model to reference model cellulase production
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Comparison of On-site and Purchased Cellulase
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## Proforma

#### EL ENZYMATIC HYDROLYSIS - PRO FORMA

erlying Assumptions & Input Variables

#### CURRENT SITUATION:

The Pro Forma models an Enzymatic Hydrolysis Ethanol plant using corn stover as the feed stock.

#### **ETHANOL**

The plant will convert corn stover to fuel grade ethanol utilizing enzymatic hydrolosis.

Corn stover feed rate of

71.977

kg/hr (str 101), produce estimated total output in

gal./short ton=

equivalent kilograms of fuel grade ETOH

9,151 3.065 kg/hr. = gal/hr =

76,871,691 kg / year (str 515)

25,746,124 gal / year

gal./metric ton=

74.1 81.7

70%

Increase to current York yearly production: The model assumes renewal of the ethanol excise tax credit of \$.54 per gallon to the blender

and NOT the small producer tax credit of \$.10 per gallon through the year 2015 for a total ethanol value of

\$1.10 per gallon or

\$0.37 per kg and

\$ 28,320,736 per year TOTAL Ethanol sales

#### CARBON DIOXIDE

Currently, carbon dioxide from the High Plains York fermentations is sold to a CO₂ compression company.

Diverting the CO₂ (stm 550) from the stover plant into this stream for sale as opposed to the atmosphere provides

110,749 kg/hr =

930,294 ton/year

with a value of \$

4.13 per metric ton WITH THIS PROFORMA NO CO2 IS SOLD. CO2 Value/year = \$0

#### LIGNIN

A Lignin co-product is produced and sold as combustion fuel material. A total amount of lignin in the stream (stm 601B) is

63,778 kg/hr = 535,734 metric ton / year is produced from the process. The water in the lignin stream must be vaporized at a net BTU cost for the stream (stm 601B). Water vaporized is

43,969 kg/hr =

369,337 metric ton/year is vaporized at 1,100 BTU/lb loss =

(107) MM BTU/hr

The remaining

19,809 kg/hr of stream 601B has

24,251 BTU/kg value = Total heating value from stream 601A is 480 MM BTU/hr 374 MM BTU/hr

Gross Lignin Value/year = \$7,848,926

Transport Cost = \$7,848,926

Net Lignin Value = \$0

#### **METHANE**

The digester produces 85% methane @

353 kg/hr (stm 615)

44,332 BTU/kg CH4

Total heating value from Methane is

16 MM BTU/hr

methane is used in the DDG dryers and based on BTU value of

\$2.50 MM BTU METHANE Value/year = \$328,822

#### DIGESTER SLUDGE

The digester produces (stm 623)

0 kg/hr of sludge as fuel =

2.254 BTU/lb

based on 9,845 btu/lb biomass and 70% water in the sludge.

4.969 BTU/kg

Total heating value from sludge is

0.00 MM BTU/hr

SLUDGE Value/year = \$0

Sale of methane and lignin, based on BTU value is

\$328,822 per year

Total projected facility sales would be

\$28,649,558 per year

### CAPITAL INVESTMENT ASSUMPTIONS

	Net Capital Investment	\$79,406,139	
FEDERAL & STATE GRANTS	10%	(\$8,822,904)	
	Total Plant Cost	\$88,229,044	
Working Capital per estimate		\$1,590,867	1 mos Raw matis. + O&M
Start-up, Permits, Fees	3.0%	\$1,876,639	
Contingency	10.0%	\$6,255,464	
. Home Office Constr. Fee	12.0%	\$7,506,557	
Field Expense	8.0%	\$5,004,371	
Process Development	2.0%	\$1,251,093	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -
INDIRECTS Prorateable	3.5%	\$2,189,412	
Fixed Capital		\$62,554,640	
Area 900		2,236,491	•
Area 800		3,684,612	
Area 700		273,557	
Area 600		9,824,251	
Area 500		7,515,486	
Area 400		8,676,000	
Area 307		3,714,334	
Area 300		4,028,307	
Area 200		14,955,166	
Area 100		6,146,434	
Civil Structural		1,500,000	
Total capital investment			

## OPERATING COST ASSUMPTIONS

8,400 hr/yr

Utilities (Rates based on	25,746,124 gal/yr produced)			7	
	<u>Amount/hr</u>	<u>Units</u>	<u>\$/unit</u>	Cost /hr.	Total Cost /yr
*Electricity	12,893	Kw-hr	\$0.035	\$451	\$3,790,636
Well water	79,972	kg	\$0.000	\$0	\$0
*Wastewater	39,119	kg	\$0.00026	\$10	\$86,808
*Gypsum waste disposal	1,137	kg	\$0.0364	\$41	\$347,327
		mTon	\$1.103	\$0	\$0
Total Utilities * Quoted by High Plains				\$503	\$4,224,771

Raw Material Costs	Amount/hr	<u>Units</u>		\$/unit	Cost /hr.		Total Cost /yr
Corn Stover DRY (stm 101 less water)	37,500	kg		\$0.016	\$597.41		\$5,018,284
*Sulfuric Acid (stm 710)	860	kg		\$0.100	\$86.26		\$724,592
, ,	337			\$0.100	\$98.70		\$829,039
*Calcium Hydroxide (Lime stm 227)	445	kg ka		\$0.293	\$72.07		\$605,374
*Ammonia (stm 717)	859	kg		\$0.162	\$43.80		\$367,909
Corn Steep Liquor (stm 735)		kg		\$0.051	\$17.48		
Nutrients (stm 415)	60	kg		\$3.000	\$0.00		\$146,846
Purchased Cellulase	0	kg			\$60.36		\$0 \$506,988
*Natural Gasoline (stm 701)	391	kg		\$0.155			, , ,
*Rolling Stock Gasoline	79	kg		\$0.155	\$12.32		\$103,470
*WWT Chemicals	5	kg		\$2.237	\$11.98		\$100,603
*CW Chemicals	17	kg		\$1.428	\$24.38		\$204,791
*BFW Chemicals	73.8	kg		\$0.226	\$16.65		\$139,833
*Boiler Fuel (stm 813)	190	Mbtu		\$2.500	\$476.07		\$3,998,989
Total Raw Materials					\$1,517		\$12,746,718
* Quoted by High Plains							
Processing Material Costs							
	<u>Amount/hr</u>	<u>Units</u>		\$/unit	<u>Cost /hr.</u>		Total Cost /yr
*Antifoam (Corn Oil)	79	kg		\$0.304	\$24	<del></del>	\$200,961
Total Processing Materials * Quoted by High Plains					\$24		\$200,961
Operations and Maintenance Costs - DRY HAN	IDLING (area 100)	each/day		wage	hr/day each		Total Cost /yr.
*Supervisors		0.5	\$	20.00	12		\$43,800
*Operators		2.0	\$	16.00	12		\$140,160
*Laborers		8.0	\$	16.00	12		\$560,640
*Maintenance		2.0	\$	16.00	12		\$140,160
Operations and Maintenance Costs - HYDROL	YSIS/FERMENTATI	ION (area 20	0, 300	, 400, 500, 60	10)		
*Supervisors		1.0	\$	20.00	12		\$87,600
*Operators		9.0	\$	16.00	8		\$420,480
*Laborers		4.0	\$	16.00	8		\$186,880
*Technicians (Includes Lab.)		3.0	\$	16.00	8		\$140,160
*Maintenance		3.0	\$	16.00	8		\$140,160
Operations and Maintenance Costs - Utilities (a	rea 700 800 900)						
*Supervisors		0.5	\$	20.00	12		\$21,900
*Operators		3.0	\$	16.00	8		\$70,080
*Laborers		1.0	\$	16.00	8		\$23,360
*Technicians		1.0	\$	16.00	8		\$23,360
*Maintenance		2.0	\$	16.00	8		\$46,720
* Quoted by High Plains Standard HPY	shifts are 12 hours						
	Total Operations a	ind maintena	nce la	bor costs			\$2,045,460

Other Operations and Maintenance	Costs		
Payroll Overhead	35% of operating labor	\$	715,911
Maintenance Costs	2% of plant cost	\$	1,251,093
Operating Supplies	0.25% of plant cost	\$	156,387
Environmental	0.50% of plant cost	\$	312,773
Local Taxes	1% of plant cost	\$	625,546
Insurance	0.50% of plant cost	\$	312,773
Overhead Costs	40% of labor, supervision, maint cost	\$	818,184
Administrative Costs	1% of annual sales (less tax credits)	\$	105,559
Distribution and Sales	0.5% of annual sales (less tax credits)	\$	-
Total O&M Costs		<u> بريد مين دخدمه</u>	\$6,343,686

#### OTHER MODEL ASSUMPTIONS

Average prevailing market price of fuel grade ETOI Assumes renewal of the ethanol excise tax credit of and the small producer tax credit of \$.10 per gallon		\$		per kg per gallon	
*Value of CO ₂ produced			\$	4.13	per metric ton
*Price for Electricity				\$0.035	per KWhr
*Gas price per million BTU				\$2.500	per MM BTU
		68%	Dry matt	er	
Corn Stover feedstock cost- dry basis/short ton	\$ 14.45	\$0.016 \$15.93	per kg per metr	ic ton	•
Plant on-stream factor				0.959	
Plant operating hours per year				8400	
Depreciable Life of Capital Equipment				15	years
Average annual commodity escalation rate:				3.0%	
Average annual cost escalation rate: * Quoted by High Plains				3.0%	

- 1. There are no land acquisiton costs included.
- There are no off site costs included (e.g. public road improvements, extensions of power, water, telephone services)
- There is a source of qualified construction personnel within daily driving distance of the site
- There exist adequate roads and rail roads to allow equipment delivery.
- 5. The costs for air and water permits are not included.
- 6. Soils are adequate for conventional foundation designs.

EL ENZYMATIC HYDROLYSIS - PRO FORMA

E 1: Produce Fuel Grade Ethanol																				A	1/26/00
ital Investment:		manth 1	month2	month3	month4	month5	month6	month7	month8	manth9	month10	month11	month 12	month13	month 14	month15	month 16	month 17	month18	TOTAL	
otal Fixed Capital Cost		\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$4,000,000	\$11,406,139	\$79,406,139	
onstruction Financing & Fees @10% pan Origination Fee @	2.0%	1,588,123	33,333	66,667	100,000	133,333	166,667	200,000	233,333	266,667	300,000	333,333	366,667	400,000	433,333	466,667	500,000	533,333	266,667	4,800,000 1,588 123	
egal Fees	2.0%	40,000																	٥	40,000	
uilder's All Risk/General Liability		50,000																	0	50,000	
Arking Capital (Financed)																			0	0	
Total Capital Investment Required		\$5,678,123	\$4,033,333	\$4,066,667	\$4,100,000 11,000	\$4,133,333	\$4,166,667	\$4,200,000	\$4,233,333	\$4,266,567	\$4,300,000	\$4,333,333	\$4,366,667	\$4,400,000	\$4,433,333	\$4,466,667	\$4,500,000	\$4,533,333	\$11,672,806	\$85,884,262	
1		Year 1:	Year 2:	Year 3:	Year 4:	Year 5:	Year 6:	Year 7;	Year 8:	Year 9:	Year 10:	Year 11:	Year 12:	Year 13:	Year 14:	Year 15:	Year 16:	Year 17;	Year 18:	Year 19:	Year 20:
rating Projection: at of fuel grade ethanol produced		1999 / 2000 25,746,124	2000/2001 25,746,124	2001/2002 25,746,124	2002/2003 25,746,124	2003/2004 25,745,124	2004/2005 25,746,124	2005/2006 25,746,124	2008/2007 25,746,124	2007/2008 25,746,124	2008/2009 25,746,124	2006 / 2007 25,746,124	2007 / 2008 25,746,124	2008 / 2009 25,746,124	2009 / 2009 25,746,124	2010 / 2011 25,746,124	2011 / 2012 25,746,124	2012 / 2013 25,746,124	2013 / 2014 25,746,124	2014 / 2015 25,746,124	2015 / 2016 25,746,124
ontract sale price per gallon		\$1,100	\$1,133	\$1.167	\$1,202	\$1.238	\$1.275	\$1.313	\$1,353	\$1.393	\$1.435	\$1.478	\$1.523	\$1.568	\$1,615	\$1.664	\$1.714	\$1.765	\$1.818	\$1,873	\$1.929
Gross Annual Revenue		\$28,320,736	\$29,170,358	\$30,045,469	\$30,946,833	\$31,875,238	\$32,831,495	\$33,816,440	\$34,630,933	\$35,875,861	\$36,952,137	\$38,060,701	\$39,202,522	\$40,378,598	\$41,589,956	\$42,837,655	\$44,122,784	\$45,446,468	\$46,809,862	\$48,214,158	\$49,660,582
mall Ethanol Producer Tax Credit  ② \$0.0000 per gal	llon	\$0	\$0	\$0	\$0	\$0	\$0	50	50	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Total projected ethanol sales and cred		\$28,320,736	\$29,170,358	\$30,045,469	\$30,946,833	\$31,875,238	\$32,831,495	\$33,816,440	\$34,830,933	\$35,875,861	\$36,952,137	\$38,060,701	\$39,202,522	\$40,378,598	\$41.589,956	\$42,837,655	<b>\$44</b> ,122,784	\$45,446,468	\$46,809,862	\$48,214,158	<b>\$</b> 49,660,582
alue of electricity		\$0.035	\$0.036	\$0.037	\$0.038	\$0.039	\$0.041	\$0.042	\$0.043	\$0.044	\$0.046	\$0.047	\$0.048	\$0.050	\$0.051	\$0.053	\$0.055	\$0.056	\$0.058	\$0,060	\$0.061
Gross Annual Co-Product Revenue		\$328,822	\$338,687	\$348,847	\$359,313	\$370,092	\$381,195	\$392,631	\$404,410	\$416,542	\$429,038	\$441,909	\$455,167	\$468,822	\$482,886	\$497,373	\$512,294	\$527,663	\$543,493	\$559,797	\$576,591
Gross Sales and Credit		\$28,649,558	\$29,509,045	\$30,394,316	\$31,306,146	\$32,245,330	\$33,212,690	\$34,209,071	\$35,235,343	\$36,292,403	\$37,381,175	\$38,502,611	\$39,657,689	\$40,847,420	\$42,072,842	\$43,335,027	\$44,635,078	\$45,974,131	\$47,353,354	\$48,773,955	\$50,237,174
perating Expenses: Utilities		4,224,771	4,351,514	4,482,059	4,616,521	4,755,017	4.897.667	5,044,597	5 105 025	5,351,813	6 512 257	5,677,739	5,848,071	6,023,513	5,204,218	6 300 345	6,582,055	6,779,517	6,982,902	7,192,389	7,408,161
Raw Materials		12,746,716	13,129,120	13,522,993	13,928,683	14,346,544	14,776,940	15,220,248	5,195,935 15,676,856	16,147,161	5,512,368 16,631,576	17,130,524	17,644,439	18,173,772	18,718,986	6,390,345 19,280,555	19,858,972	20,454,741	21,068,383	21,700,435	22,351,448
Processing Materials		200,961	206,990	213,200	219,596	226,184	232,969	239,958	247,157	254,572	262,209	270,075	278,177	286,523	295,119	303,972	313,091	322,484	332,158	342,123	352,387
Operation & Maintenance Property Tax @ 0,50% Book V	/alue	6,343,686 429,421	6,533,997 402,953	6,730,017 376,484	6,931,917 350.015	7,139,875 323,546	7,354,071 297,078	7,574,693 270.609	7,801,934 244,140	8,035,992 217,672	8,277,072 191,203	8,525,384 164 734	8,781,145 138,265	9,044,580 111,797	9,315,917 85.328	9,595,395 58,859	9,883,257 58,859	10,179,754 58,859	10,485,147 58,859	10,799,701 58,859	11,123,692 58,859
Depreciation 0.55% Book V	- u. ut	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	5,293,743	0 0	30,039	30,039	0	0
Total Operating Expense		\$29,239,301	\$29,918,316	\$30,618,496	\$31,340,475	\$32,084,908	\$32,852,468	\$33,643,849	\$34,459,765	\$35,300,953	\$36,168,170	\$37,062,198	\$37,983,841	\$38,933,927	\$39,913,310	\$40,922,869	\$36,696,234	\$37,795,355	\$38,927,450	\$40,093,508	\$41,294,547
Net Operating Income		(\$589,742)	(\$409,271)	(\$224,180)	(\$34,330)	\$160,422	\$360,222	\$565,222	\$775,578	\$991,450	\$1,213,005	\$1,440,412	\$1,673,848	\$1,913,492	\$2,159,532	\$2,412,159	\$7,938,844	\$8,178,775	\$8,425,904	\$8,680,447	\$8,942,626
Net Operating Cash Flow		\$4,704,000	\$4,884,471	\$5,069,563	\$5,259,413	\$5,454,165	\$5,653,965	\$5,858,965	\$6,069,321	\$6,285,193	\$6,506,748	\$6,734,155	\$6,967,590	\$7,207,235	\$7,453,274	\$7,705,901	\$7,938,844	\$8,178,775	\$8,425,904	\$8,680,447	\$5,942,626
E 1: Hypothetical Financing Scenario	s:																				
E 1A: 100% Debt Financing																					
nortization 15 yrs		Year 1:	Year 2:	Year 3;	Year 4:	Year 5:	Year 6:	Year 7;	Year 8:	Year 9:	Year 10:	Year 11:	Year 12:	Year 13:	Year 14:	Year 15:	Year 16:	Year 17:	Year 18:	Year 19:	Year 20:
terest Rate 7,00%		1999 / 2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2006 / 2007	2007 / 2008	2008 / 2009	2009 / 2009	2010 / 2011	2011/2012	2012 / 2013	2013/2014	2014 / 2015	2015 / 2016
et Operating Cash Flow (from above)		4,704,000	4,884,471	5,069,563	5,259,413	5,454,165	5,653,965	5,858,965	6,069,321	6,285,193	6,506,748	6,734,155	6,967,590	7,207,235	7,453,274	7,705,901	7,938,844	8,178,775	8,425,904	8,680,447	8,942,626
Debt Interest		6,011,898	5,772,657	5,516,669	5,242,762	4,949,681	4,636,084	4,300,536	3,941,500	3,557,330	3,146,269	2,706,434	2,235,810	1,732,243	1,193,426	616,892	0	0	0	0	0
Debt Principal Total Debt Service		3,417,732 9,429,630	3,656,973 9,429,630	3,912,961 9,429,630	9,429,630	9,429,630	9,429,630	5,129,094 9,429,630	5,488,131 9,429,630	5,872,300 9,429,630	6,283,361 9,429,630	6,723,196 9,429,630	7,193,820 9,429,630	7,697,387 9,429,630	8,236,204 9,429,630	8,812,739 9,429,630	(0)	(0)	<u>(0)</u>	(0)	(0)
Net Cash Flow after Debt Service		(4,725,630)	(4,545,159)	(4,360,067)	(4,170,217)	(3,975,466)	(3,775,666)	(3,570,666)	(3,360,310)	(3,144,437)	(2,922,883)	(2,695,475)	(2,462,040)	(2,222,396)	(1,976,356)	(1,723,729)	7,938,844	8,178,775	8,425,904	8,680,447	8,942,626
Debt Service Coverage Ratio		0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.67	0.69										
Total Pre-tax Net Cash Flow (20 yrs)		(\$7,463,900)																			
E 18: 100% Cash Financing																					
	ear O;	Year 1:	Year 2:	Year 3;	Year 4:	Year 5:	Year 6:	Year 7:	Year 8:	Year 9;	Year 10:	Year 11:	Year 12:	Year 13:	Year 14:	Year 15:	Year 16:	Year 17:	Year 18:	Year 19:	Year 20:
et Cash Flow (85	i,884,262)	4,704,000	4,884,471	5,069,563	5,259,413	5,454,165	5,653,965	5,858,965	6,069,321	6,285,193	6,506,748	6,734,155	6,967,590	7,207,235	7,453,274	7,705,901	7,938,844	6,178,775	8,425,904	8,580,447	8,942,626
otal Pre-tax Net Cash Flow (20 yrs)	JAT C V C. 1	\$48,096,293																			
IRR @ 100 ayback Period ( <i>Pre-tax; undiscounted)</i>	J% CASH	4.15% (18.3)	years																		

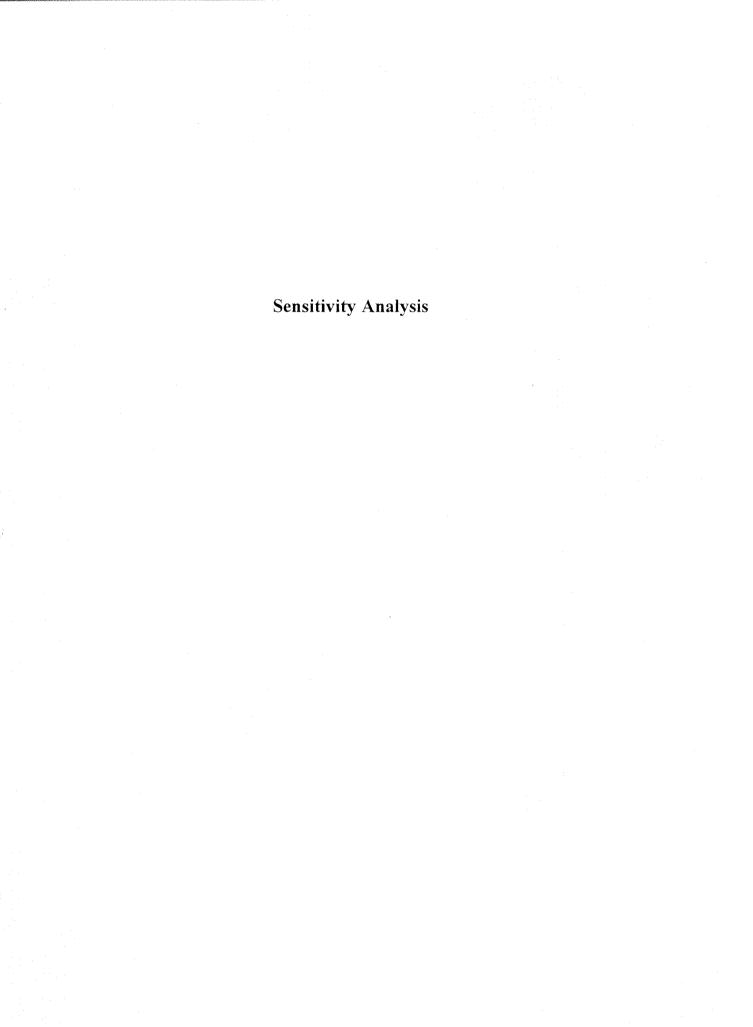
Stover-to-Eu.a., of Plant

SE 1C: Combined Equity	& Debt Fine	ıncıng																				
quity Portion	25.00%	\$21,471,066	Amortization		15	yrs																
ebt Partion	75.00%	\$64,413,197	Interest Rate		7.00%																	
		Year 0: 1997/1998	Year 1: 1999 / 2000	Year 2: 2000/2001	Year 3: 2001/2002	Year 4: 2002/2003	Year 5: 2003/2004	Year 5: 2004/2005	Year 7: 2005/2006	Year 8: 2006/2007	Year 9: 2007/2008	Year 10: 2008/2009	Year 11: 2006 / 2007	Year 12: 2007 / 2008	Year 13: 2008 / 2009	Year 14; 2009 / 2009	Year 15: 2010 / 2011	Year 16: 2011 / 2012	Year 17: 2012 / 2013	Year 18; 2013 / 2014	Year 19: 2014 / 2015	Year 20: 2015 / 2016
et Operating Cash Flow		0	4,704,000	4,884,471	5,069,563	5,259,413	5,454,165	5,653,965	5,858,965	6,069,321	6,285,193	6,506,748	6,734,155	6,967,590	7,207,235	7,453,274	7,705,901	7,938,844	8,178,775	8,425,904	8,680,447	8,942,626
Debt Interest			4,508,924	4,329,493	4,137,502	3,932,071	3,712,261	3,477,063	3,225,402	2,956,125	2,667,998	2,359,702	2,029,826	1,676,858	1,299,182	895,070	462,669	0	o	0	0	0
Debt Principal			2,563,299	2,742,730	2,934,721	3,140,151	3,359,962	3,595,159	3,846,821	4,116,098	4,404,225	4,712,521	5,042,397	5,395,365	5,773,040	6,177,153	6,609,554	(0)	(0)	(0)	(0)	(0)
Total Debt Service			7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	7,072,223	0	0	0	0	0
Net Cash Flow		(21,471,066)	(2,368,223)	(2,187,751)	(2,002,660)	(1,812,810)	(1,618,058)	(1,418,258)	(1,213,258)	(1,002,902)	(787,030)	(565,475)	(338,068)	(104,632)	135,012	381,052	633,678	7,938,844	8,178,775	8,425,904	8,680,447	8,942,626
ebt Service Coverage Ri	etio		0.67	0.69	0.72	0.74	0.77	0.80	0.83	0.86	0.89	0.92	0.95	0.99	1.02	1.05	1.09	#DIV/0!	#DIV/O!	#DIV/0!	#DIV/0!	#DIV/0!
otal Pre-tax Net Cash Flo	ow (20 yrs)		\$6,426,149																			

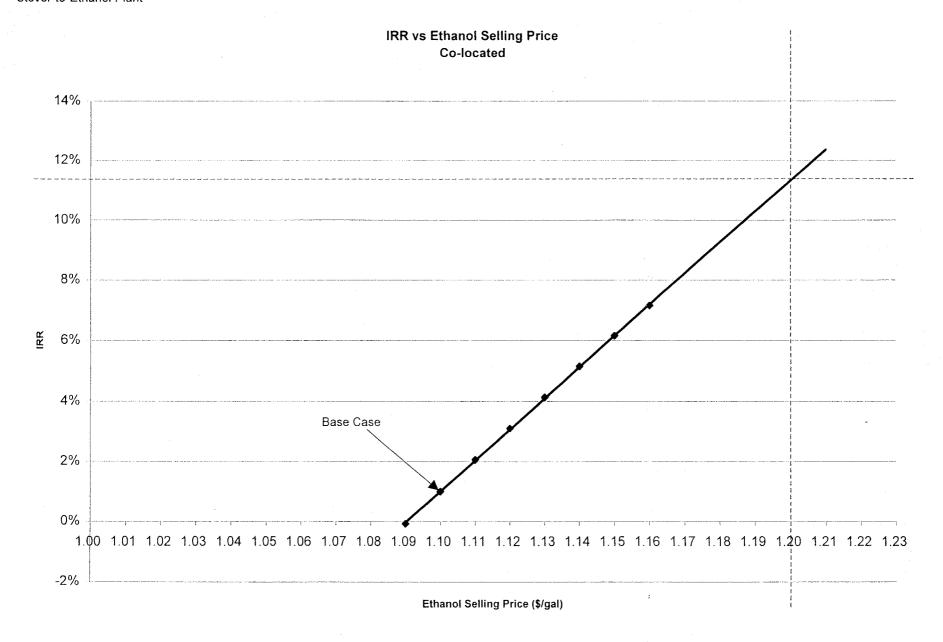
ternal Rate of Return (IRR Pre-Tax) 1.0%

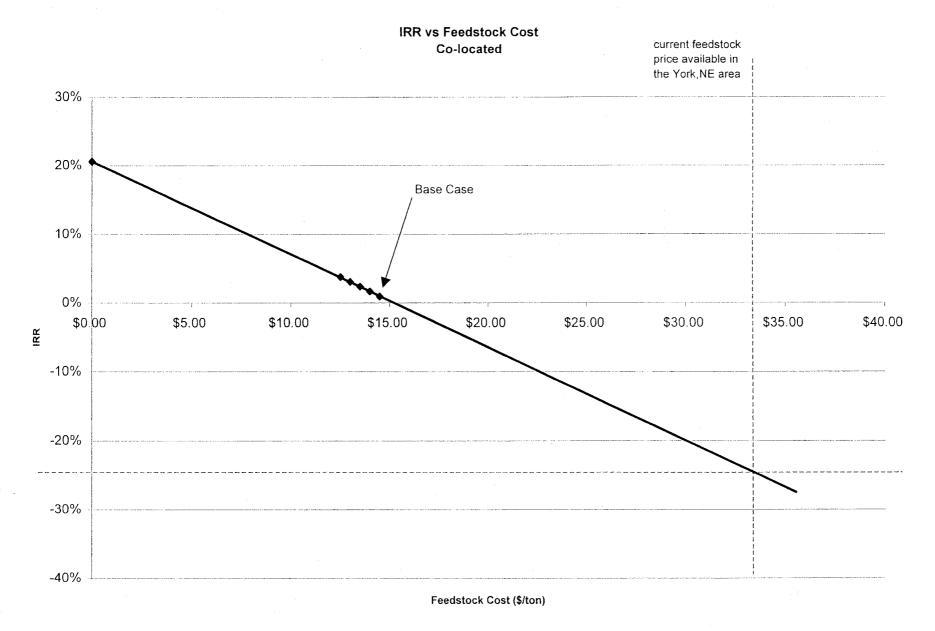
odified Internal Rate of Return (MIRR Pre-tax)

1.4% (excludes any assumption of project terminal value)

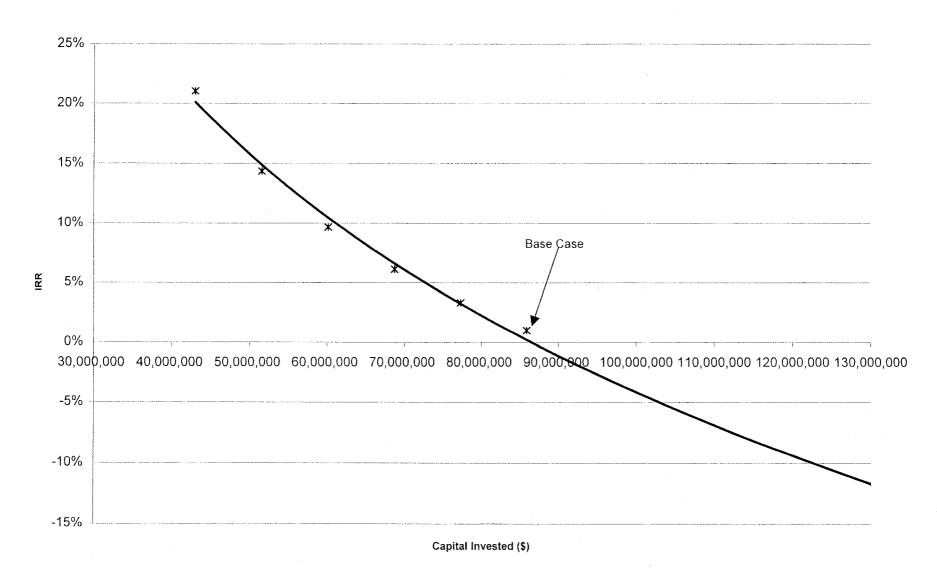


CASH   RATE OF   FEED PRICE   ETHANOL   SALE % GAL		20 YR. NET							
FLOW \$ RETURN   DRY \$TON   SALE \$\( \) SALE \$\( \) SALE \$\( \) (3,950,971)   -1%   14.450   1.09   1.085   1.09   1.085   1.09   1.09   1.085   1.09   1.09   1.09   1.09   1.09   1.09   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.00   1.0			RATE OF	FEED PRICE	ETHANOL				
E1 (3,950,971)									
E3	E1 _	(3,950,971)	-1%						
E4 13,344,229 2% 14.450 1.11 E5 20,262,308 3% 14.450 1.12 E6 27,180,388 4% 14.450 1.13 E7 34,098,468 5% 14.450 1.15 E9 47,934,628 7% 14.450 1.16 E8 41,016,548 6% 14.450 1.15 E9 47,934,628 7% 14.450 1.10 F1 141,269,327 21% 0.000 1.10 F2 24,622,979 4% 12.500 1.10 F3 19,957,125 3% 13.000 1.10 F5 10,625,417 2% 14.000 1.10 F6 5,959,563 1% 14.500 1.10 F6 5,959,563 1% 14.450 1.10 F6 5,959,563 1% 14.450 1.10 Cap1 72,181,553 21% 14.450 1.10 50% 42,942,131 \$1.67 Cap2 59,030,472 14% 14.450 1.10 50% 42,942,131 \$1.67 Cap3 45,879,391 10% 14.450 1.10 50% 60,118,983 \$2.34 Cap4 32,728,310 6% 14.450 1.10 70% 60,118,983 \$2.34 Cap4 32,728,310 6% 14.450 1.10 90% 67,707,410 \$2.67 Cap5 19,577,229 3% 14.450 1.10 90% 68,707,410 \$2.67 Cap5 6,426,149 1% 14.450 1.10 100% 85,884,262 \$3.34 BASE CASE Cap6 6,426,149 1% 14.450 1.10 100% 85,884,262 \$3.34 BASE CASE Cap7 (6,724,932) #NUM! 14.450 1.10 110% 94,472,888 \$3.67 Cap8 (19,876,013) #NUM! 14.450 1.10 120% 103.061,115 \$4.00 Cap9 (33,027,094) #DIV/O! 14.450 1.10 140% 120,237,967 \$4.67 Cap11 (69,329,255) #DIV/O! 14.450 1.10 140% 120,237,967 \$4.67 Cap11 (59,329,255) #DIV/O! 14.450 1.10 140% 120,237,967 \$4.67 Cap11 (59,329,255) #DIV/O! 14.450 1.10 59.32 20,596,899 80% p3 (221,870,488) #DIV/O! 14.450 1.10 59.32 20,596,899 80% p4 (145,771,608) #DIV/O! 14.450 1.10 59.32 20,596,899 80% p5 1,099,227 0% 14.450 1.10 59.32 20,596,899 80% p6 6,426,149 1% 14.450 1.10 59.32 20,596,899 80%	E2	(491,931)	0%	14.450	1.09				
E5	E3	6,426,149	1%	14.450	1.10		BASE CASE		
E6   27,180,388	E4	13,344,229	2%	14.450	1.11				
E7 34,098,468 5% 14,450 1.14 E8 41,016,548 6% 14,450 1.15 E9 47,934,628 7% 14,450 1.16  F1 141,269,327 21% 0.000 1.10 F2 24,622,979 4% 12,500 1.10 F3 19,957,125 3% 13,000 1.10 F4 15,291,271 2% 13,500 1.10 F5 10,625,417 2% 14,000 1.10 F6 5,959,563 1% 14,500 1.10 F6 5,959,563 1% 14,500 1.10  Cap1 72,181,553 21% 14,450 1.10 50% 42,942,131 \$ 1.67  Cap2 59,030,472 14% 14,450 1.10 60% 51,530,557 \$ 2.00  Cap3 45,879,391 10% 14,450 1.10 60% 68,707,410 \$ 2.67  Cap4 32,728,310 6% 14,450 1.10 80% 68,707,410 \$ 2.67  Cap5 19,577,229 3% 14,450 1.10 90% 77,295,836 \$ 3.00  Cap6 6,426,149 1% 14,450 1.10 100% 85,884,262 \$ 3.34 BASE CASE  Cap7 (6,724,932) #NUM! 14,450 1.10 100% 85,884,262 \$ 3.34 BASE CASE  Cap8 (19,876,013) #NUM! 14,450 1.10 100% 85,884,262 \$ 3.34 BASE CASE  Cap7 (6,724,932) #NUM! 14,450 1.10 100% 85,884,262 \$ 3.34 BASE CASE  Cap8 (19,876,013) #NUM! 14,450 1.10 120% 103,061,115 \$ 4.00  Cap9 (33,027,094) #DIV/0! 14,450 1.10 130% 111,649,541 \$ 4.34  Cap10 (46,178,175) #DIV/0! 14,450 1.10 150% 128,826,393 \$ 5.00  E8 2 (297,969,366) #DIV/0! 14,450 1.10 150% 128,826,393 \$ 5.00  E9 (297,969,366) #DIV/0! 14,450 1.10 150% 128,826,393 \$ 5.00  E9 (297,969,366) #DIV/0! 14,450 1.10 150% 128,826,393 \$ 5.00  E9 (297,969,366) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (145,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (145,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (6,426,149 1% 14,450 1.10 73,63 22,056,899 80%  E9 (297,969,366) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (445,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (475,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (475,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (475,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  E9 (476,6149 1% 14,450 1.10 73,63 22,565,591! 99,30%  E9 (476,6149 1% 14,450 1.10 73,63 22,556,591! 99,30%	E5	20,262,308	3%	14.450	1.12				
E8 41,016,548 6% 14,450 1.16  F1 141,269,327 21% 0.000 1.10  F2 24,622,979 4% 12,500 1.10  F3 19,957,125 3% 13,000 1.10  F5 10,625,417 2% 14,000 1.10  F6 5,959,563 1% 14,500 1.10  Cap1 72,181,553 21% 14,450 1.10 50% 42,942,131 \$1,67  Cap2 59,030,472 14% 14,450 1.10 50% 42,942,131 \$1,67  Cap3 45,879,391 10% 14,450 1.10 60% 51,530,557 \$2.00  Cap3 45,879,391 10% 14,450 1.10 80% 68,707,410 \$2.67  Cap5 19,577,229 3% 14,450 1.10 80% 68,707,410 \$2.67  Cap6 6,426,149 1% 14,450 1.10 100% 88,884,262 \$3.34 BASE CASE  Cap7 (6,724,932) #NUM! 14,450 1.10 100% 88,884,262 \$3.34 BASE CASE  Cap7 (6,724,932) #NUM! 14,450 1.10 100% 88,884,262 \$3.34 BASE CASE  Cap7 (6,724,932) #NUM! 14,450 1.10 100% 88,884,262 \$3.67  Cap8 (19,876,013) #NUM! 14,450 1.10 110% 94,472,688 \$3.67  Cap9 (33,027,094) #DIV/0! 14,450 1.10 120% 103,061,115 \$4.00  Cap9 (33,027,094) #DIV/0! 14,450 1.10 150% 112,839,541 \$4.34  Cap10 (46,178,175) #DIV/0! 14,450 1.10 150% 120,237,967 \$4.67  Cap11 (59,329,255) #DIV/0! 14,450 1.10 150% 120,237,967 \$4.67  Cap12 (297,989,366) #DIV/0! 14,450 1.10 150% 120,237,967 \$4.67  Cap14 (145,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  P4 (145,771,609) #DIV/0! 14,450 1.10 51.90 18,022,287 70%  P5 (1,099,227 0% 14,450 1.10 73,63 25,568,501 99.30%  P6 (6,426,149 1% 14,450 1.10 74,15 25,746,124 100% BASE CASE	E6	27,180,388	4%	14.450	1.13				
E9         47,934,628         7%         14,450         1,16           F1         141,269,327         21%         0,000         1,10           F2         24,622,979         4%         12,500         1,10           F3         19,957,125         3%         13,000         1,10           F4         15,291,271         2%         13,500         1,10           F5         10,625,417         2%         14,000         1,10           F6         5,959,563         1%         14,500         1,10         50%         42,942,131         \$ 1,67           cap1         72,181,553         21%         14,450         1,10         60%         51,530,557         \$ 2.00           cap2         59,030,472         14%         14,450         1,10         60%         51,530,557         \$ 2.00           cap3         45,879,391         10%         14,450         1,10         70%         60,118,893         \$ 2.34           cap4         32,728,310         6%         14,450         1,10         80%         68,707,410         \$ 2.67           cap5         19,577,229         3%         14,450         1,10         90% <th< th=""><th>E7</th><th>34,098,468</th><th>5%</th><th>14.450</th><th>1.14</th><th></th><th></th><th></th><th></th></th<>	E7	34,098,468	5%	14.450	1.14				
F1 141,269,327 21% 0,000 1.10 F2 24,622,979 4% 12.500 1.10 F3 19,957,125 3% 13.000 1.10 F4 15,291,271 2% 13.500 1.10 F5 10,625,417 2% 14.000 1.10 F6 5,959,563 1% 14.500 1.10  Cap1 72,181,553 21% 14.450 1.10 50% 42,942,131 \$1.67 cap2 59,030,472 14% 14.450 1.10 60% 51,530,557 \$2.00 cap3 45,879,391 10% 14.450 1.10 80% 68,707,410 \$2.67 cap4 32,728,310 6% 14.450 1.10 80% 68,707,410 \$2.67 cap5 19,577,229 3% 14.450 1.10 90% 77,295,836 \$3.00 cap6 6,426,149 1% 14.450 1.10 100% 85,884,262 \$3.34 BASE CASE cap7 (6,724,932) #NUM! 14.450 1.10 100% 85,884,262 \$3.34 BASE CASE cap7 (6,724,932) #NUM! 14.450 1.10 110% 94,472,688 \$3.67 cap8 (19,876,013) #NUM! 14.450 1.10 120% 103,061,115 \$4.00 cap9 (33,027,094) #DIV/0! 14.450 1.10 130% 111,649,541 \$4.34 cap10 (46,178,175) #DIV/0! 14.450 1.10 150% 128,826,393 \$5.00  P1 (374,068,245) #DIV/0! 14.450 1.10 150% 128,826,393 \$5.00  P2 (297,969,366) #DIV/0! 14.450 1.10 51.90 18,022,287 70% p4 (145,771,609) #DIV/0! 14.450 1.10 51.90 18,022,287 70% p4 (145,771,609) #DIV/0! 14.450 1.10 59,32 20,566,899 80% p5 1,099,227 0% 14.450 1.10 73.63 25,566,901 99,30% p6 6,426,149 1% 14.450 1.10 73.63 25,566,901 99.30% p6 6,426,149 1% 14.450 1.10 73.63 25,566,901 99.30% p6 6,426,149 1% 14.450 1.10 73.63 25,566,901 99.30% p6 6,426,149 1% 14.450 1.10 74.15 25,746,124 100% BASE CASE	E8	41,016,548	6%	14.450	1.15				
F2 24,622,979 4% 12.500 1.10 F3 19,957,125 3% 13.000 1.10 F5 10,625,417 2% 14.000 1.10 F6 5.959,563 1% 14.500 1.10  S/gal of  CAPITAL INVEST capacity  S/gal	E9	47,934,628	7%	14.450	1.16	_			
F2 24,622,979 4% 12.500 1.10 F3 19,957,125 3% 13.000 1.10 F5 10,625,417 2% 14.000 1.10 F6 5.959,563 1% 14.500 1.10  S/gal of  CAPITAL INVEST capacity  S/gal									
F3 19,957,125 3% 13.000 1.10 F4 15,291,271 2% 13.500 1.10 F5 10,625,417 2% 14.000 1.10 F6 5,959,563 1% 14.500 1.10									
F4         15,291,271         2%         13,500         1.10           F5         10,625,417         2%         14,000         1.10           \$/gsl of           \$         \$/gsl of           \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$         \$									
F5         10,625,417         2%         14.000         1.10           F6         5,959,563         1%         14.500         1.10           \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of                \$/gal of									

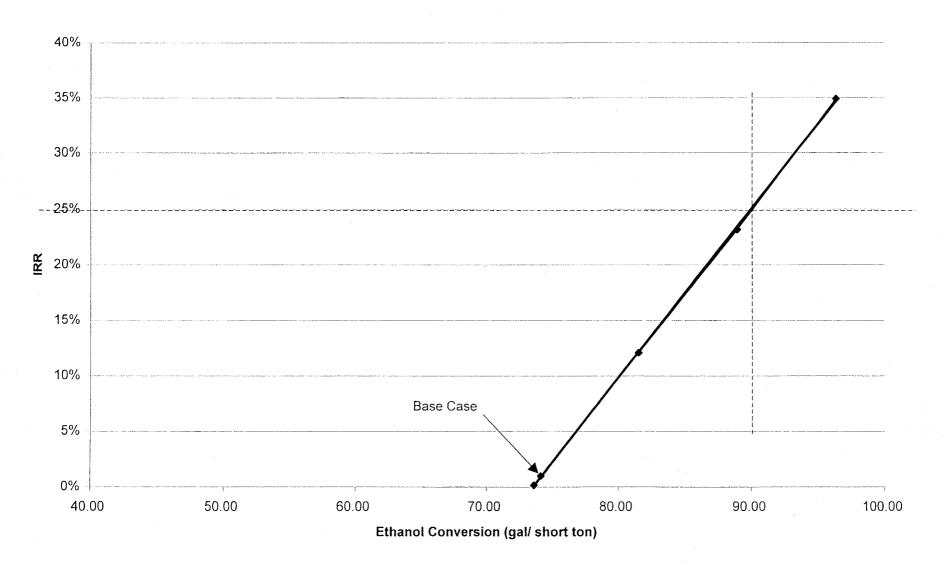




IRR vs Capital Invested Co-located



## IRR vs Ethanol Conversion Co-located







### Summary of On-sites

**Pure Vision** 

1,201,055

## Comparison of On-Site Cellulase Production via Pure Vision Technology and NREL Reference Model

NREL*

		MF	PU required/yr**	difference	M	FPU required/yr
			1,446,984	 (50,708)		1,497,692
ng Projection:						
of fuel grade ethanol produced		\$	25,434,849	\$ (311,275)	\$	25,746,124
tract sale price per gallon		\$	1	\$ -	\$	1
Pross Annual Revenue		\$	27,978,334	\$ (342,402)	\$	28,320,736
all Ethanol Producer Tax Credit						
@ \$ - per gallon		\$	<u></u>		\$	=
Total projected ethanol sales and credit		\$	27,978,334	\$ (342,402)	\$	28,320,736
Bross Annual Co-Product Revenue		\$	328,822	\$ -	\$	328,822
Gross Sales and Credit		\$	28,307,156	\$ (342,402)	\$	28,649,558
rating Expenses:						
tilities		\$	4,792,171	\$ 567,400	\$	4,224,771
aw Materials		\$	12,843,241	\$ 96,523	\$	12,746,718
rocessing Materials		\$	267,948	\$ 66,987	\$	200,961
peration & Maintenance		\$	6,414,114	\$ 70,428	\$	6,343,686
roperty Tax @ 0.50% Book Value		\$	486,736	\$ 57,315	\$	429,421
epreciation		\$	6,038,644	\$ 744,902	\$	5,293,743
Total Operating Expense		\$	30,842,855	\$ 1,603,554	\$	29,239,301
et Operating Income		\$	(2,535,699)	\$ (1,945,956)	\$	(589,742)
et Operating Cash Flow		\$	3,502,945	\$ (1,201,055)	\$	4,704,000
enzyme cost (cost of production						
calculated in "\$per lb. calcs.") divided by						
lbs. per year flow rate from mass balance.	\$/Ib	\$	0.027		\$	0.020
enzyme cost (cost of production						
calculated in "\$per lb. calcs.") divided by						
million FPU per year required.	\$/MFPU	\$	4.60		\$	3.32

Annual Savings Using PureVision On-Site Enzyme Production **OVER REFERENCE MODEL: \$** 

^{* 45%} scale factor applied, SHCF

^{* *} MFPU = million FPU

#### JDY MODEL WITH REFRENCE MODEL CELLULASE PRODUCTION FOR COMPARISON OF ON-SITE ENZYME PRODUCTION VS. PURCHASE LOSS OF ETOH PRODUCTION POSSIBLE: 111 kg/hr

10/27/99

#### ENZYMATIC HYDROLYSIS - PRO FORMA

ing Assumptions & Input Variables

RRENT SITUATION:

The Pro Forma models an Enzymatic Hydrolysis Ethanol plant using corn stover as the

ETHANOL

The plant will convert corn stover to fuel grade ethanol utilizing enzymatic hydrolosis.

Corn stover feed rate of

71.977 kg/hr (str 101), produce estimated total output in

equivalent kilograms of fuel grade ETOH

9,041 kg/hr. = gal/hr =

75,942,299 kg / year (str 515)

gal./short ton=

73.3

3.028

25,434,849 gal / year

gal./metric ton

80.7

Increase to current York yearly production:

69%

The model assumes renewal of the ethanol excise tax credit of \$.54 per gallon to the blender

and NOT the small producer tax credit of \$.10 per gallon through the year 2015 for a total ethanol value of

\$1.10 per gallon or

\$0.37 per kg and

\$ 27,978,334 per year TOTAL Ethanol sales

CARBON DIOXIDE

Currently, carbon dioxide from the High Plains York fermentations is sold to a CO₂ compression company.

Diverting the CO₂ (stm 550) from the stover plant into this stream for sale as opposed to the atmosphere provides

110,749 kg/hr =

930,294 ton / year

with a value of \$

4.13 per metric ton

WITH THIS PROFORMA NO CO₂ IS SOLD. CO₂ Value/year = \$0

LIGNIN

A Lignin co-product is produced and sold as combustion fuel material. A total amount of lignin in the stream (stm 601B) is

63,778 kg/hr = 535,734 metric ton / year is produced from the process.

The water in the lignin stream must be vaporized at a net BTU cost for the stream (stm 601B). Water vaporized is

369,337 metric ton/year is vaporized at 1,100 BTU/lb loss =

(107) MM BTU/hr

The remaining 19,809 kg/hr of stream 601B has

24.251 BTU/kg value =

480 MM BTU/hr

Total heating value from stream 601A is

374 MM BTU/hr

Gross Lignin Value/year = \$7,848,926

Transport Cost = \$7,848,926

Net Lignin Value = \$0

**METHANE** 

The digester produces 85% methane @

353 kg/hr (stm 615)

44,332 BTU/kg CH4

Total heating value from Methane is

16 MM BTU/hr

methane is used in the DDG dryers and based on BTU value of

\$2.50 MM BTU METHANE Value/year = \$328,822

DIGESTER SLUDGE

The digester produces (stm 623)

0 kg/hr of sludge as fuel =

based on 9,845 btu/lb biomass and 70% water in the sludge.

2,254 BTU/lb 4,969 BTU/kg

0.00 MM BTU/hr

Total heating value from sludge is

SLUDGE Value/year = \$0

Sale of methane and lignin, based on BTU value is

\$328,822 per year

Total projected facility sales would be

\$28,307,156 per year

### APITAL INVESTMENT ASSUMPTIONS

Civil Structural Area 100 Area 200 Area 300 Area 307 Area 400 Area 500		1,500,000 6,146,434 14,955,166 4,028,307 3,714,334 10,353,995 7,515,486 9,824,251	
Area 200 Area 300 Area 307 Area 400		14,955,166 4,028,307 3,714,334 10,353,995 7,515,486	
Area 300 Area 307 Area 400		4,028,307 3,714,334 10,353,995 7,515,486	
Area 307 Area 400		3,714,334 10,353,995 7,515,486	
Area 400		10,353,995 7,515,486	
		7,515,486	
Area 500			
		9,824,251	
Area 600			
Area 700		282,716	
Area 800		3,684,612	
Area 900		2,236,491	
Fixed Capital		\$64,241,793	
INDIRECTS Prorateable	3.5%	\$2,248,463	
Process Development	2.0%	\$1,284,836	
Field Expense	8.0%	\$5,139,343	
Home Office Constr. Fee	12.0%	\$7,709,015	
Contingency	10.0%	\$6,424,179	
Start-up, Permits, Fees	3.0%	\$1,927,254	
Working Capital per estimate		<b>\$1</b> ,6 <b>04,780</b> 1 m	ios Raw matls. + O&M
•	Total Plant Cost	\$90,579,663	
FEDERAL & STATE GRANTS	10%	(\$9,057,966)	
	Net Capital Investment	\$81,521,697	

PERATING COST ASSUMPTIONS

8,400 hr/yr

Utilities (Rates based on	25,434,849 gal/yr produced)				
	<u>Amount/hr</u>	<u>Units</u>	\$/unit	Cost /hr.	Total Cost /yr
*Electricity	14,823	Kw-hr	\$0.035	\$519	\$4,358,036
Well water	79,972	kg	\$0.000	\$0	\$0
*Wastewater	39,119	kg	\$0.00026	\$10	\$86,808
*Gypsum waste disposal	1,137	kg	\$0.0364	\$41	\$347,327
		mTon	\$1.103	\$0	\$0
Total Utilities * Quoted by High Plains				\$570	\$4,792,171

Raw Material Costs						
	<u>Amount/hr</u>	<u>Units</u>		\$/unit	Cost /hr.	Total Cost /yr
Corn Stover DRY (stm 101 less water)	37,500	kg		\$0.016	\$597.41	\$5,018,284
*Sulfuric Acid (stm 710)	860	kg		\$0.100	\$86.26	\$724,592
*Calcium Hydroxide (Lime stm 227)	337	kg		\$0.293	\$98.70	\$829,039
*Ammonia (stm 717)	464	kg		\$0.162	\$75.17	\$631,405
Corn Steep Liquor (stm 735)	909	kg		\$0.051	\$46.36	\$389,452
Nutrients (stm 415)	80	kg		\$0.291	\$23.31	\$195,794
Purchased Cellulase	0	kg		\$3.000	\$0.00	\$0
*Natural Gasoline (stm 701)	391	kg		\$0.155	\$60.36	\$506,988
*Rolling Stock Gasoline	79	kg		\$0.155	\$12.32	\$103,470
*WWT Chemicals	5	kg		\$2.237	\$11.98	\$100,603
*CW Chemicals	17	kg		\$1.428	\$24.38	\$204,791
*BFW Chemicals	73.8	kg		\$0.226	\$16.65	\$139,833
*Boiler Fuel (stm 813)	190	Mbtu		\$2.500	\$476.07	\$3,998,989
· ·	100			42.000	• 11 0.01	45,050,000
Total Raw Materials					\$1,529	\$12,843,241
* Quoted by High Plains					ψ / , <b>02</b> 0	Ψ / <b>L</b> , σ (σ, <b>L</b> / )
Processing Material Costs						
	Amount/hr	<u>Units</u>		<u>\$/unit</u>	Cost /hr.	Total Cost /yr
*Antifoam (Corn Oil)	105	kg		\$0.304	\$32	\$267,948
Total Processing Materials					\$32	\$267,948
* Quoted by High Plains						
Operations and Maintenance Costs - DRY HAN	IDLING (area 100	each/day		wage	hr/day each	Total Cost /yr.
*Supervisors		0.5	\$	20.00	12	\$43,800
*Operators		2.0	\$	16.00	12	\$140,160
*Laborers		8.0	\$	16.00	12	\$560,640
*Maintenance		2.0	\$	16.00	12	\$140,160
Operations and Maintenance Costs - HYDROL	YSIS/FERMENTAT	ΓΙΟΝ (area 2	00, 30	00, 400, 500	600)	
*Supervisors		1.0	\$	20.00	12	\$87,600
*Operators		9.0	\$	16.00	8	\$420,480
*Laborers		4.0	\$	16.00	8	\$186,880
*Technicians (Includes Lab.)		3.0	\$	16.00	8	\$140,160
*Maintenance		3.0	\$	16.00	8	\$140,160
Operations and Maintenance Costs - Utilities (a	rea 700, 800, 900)					
*Supervisors		0.5	\$	20.00	12	\$21,900
*Operators		3.0	\$	16.00	8	\$70,080
*Laborers		1.0	\$	16.00	8	\$23,360
*Technicians		1.0	\$	16.00	8	\$23,360
*Maintenance		2.0	\$	16.00	8	\$46,720
* Quoted by High Plains Standard HPY	shifts are 12 hours.					
- Quoted by night Flams Standard HPT S	simis are 12 nours.					

Total Operations and maintenance labor costs

\$2,045,460

Other Operations and Maintenance Costs							
Payroll Overhead	35% of operating labor				\$	•	
Maintenance Costs	2% of plant cost				\$		
Operating Supplies	0.25% of plant cost				\$		
Environmental	0.50% of plant cost				\$		
Local Taxes	1% of plant cost				\$		
Insurance	0.50% of plant cost				\$	e .	
Overhead Costs	40% of labor, supervision	n,maint	cost		\$		
Administrative Costs	1% of annual sales (less	s tax cre	dits)		\$		
Distribution and Sales	0.5% of annual sales (le	ess tax c	redits)		\$		
Total O&M Costs					·		
THER MODEL ASSUMPTIONS							
erage prevailing market price of fuel grade ETO sumes renewal of the ethanol excise tax credit of the small producer tax credit of \$.10 per gallor	of \$.54 per gallon		<ul> <li>J. S. C. S. C. Control of Charles and Press (1998).</li> </ul>	per kg per gallon			
/alue of CO ₂ produced			\$ 4.13	per metric to	ń		
Price for Electricity			\$ 0.035	per KWhr			
Sas price per million BTU			\$ 2.500	per MM BTU			
			Dry matter	•			
rn Stover feedstock cost- dry basis/short ton	\$ 14,45	\$0.016					
		\$15.93	per metric ton				
ant on-stream factor			0 959	est (free			

ant on-stream factor

0.959

ant operating hours per year

8,400

epreciable Life of Capital Equipment

15 years

erage annual commodity escalation rate:

3.0%

rerage annual cost escalation rate:

3.0%

#### * Quoted by High Plains

There are no land acquisiton costs included.

There are no off site costs included (e.g. public road

improvements, extensions of power, water, telephone services)

There is a source of qualified construction personnel within daily

driving distance of the site

There exist adequate roads and rail roads to allow

equipment delivery.

The costs for air and water permits are not included.

Soils are adequate for conventional foundation designs.

715,911 1,284,836 160,604 321,209 642,418 321,209 818,184 104,283

\$6,414,114

		<del></del>		1	Scaling	New		Original		Total Original					Scaled			
Equip	No.	No.		Scaling	Stream Flow	Stream	Size	Equip Cost	Base	Equip Cost (Reg'd	Scaling	Scaled Cost in	Install		Uninstalled		-	
No.	Req'd	Spare	Equip Name	Stream	(Kg/hr)	Flow	Ratio	(per unit)	Year	& Spare)	Exponent	Base Year	Factor	Installed Cost	Cost in 1999\$	Description	3442	WORK
-101	1	0	Bale conveyor	AREA0100	154	170	1.11	\$15,000		\$15,000	0.6	\$15,927	1.5	<b>\$</b> 24,551		wire mesh conveyor 60" wide 20' long	WC101	11.9
-102	1	0	Radial Stacker Conveyor	AREA0100	154	170	1.11	\$159,830	1999	\$159,830	0.6	\$169,708	1.5	\$261,604	\$ 169,708	16 degree, 36" x 200' radial stacker, 750 ton/hr, 75 HP	WC102	44,7
				1			Ī								1	84" x 35' rubber belt cleated infeed conveyor, 10 HP, TEFC drive motor		
-103	1	0	Breaker Infeed Belt	AREA0100	154	170	1.11	\$49,500		\$49,500	0.6	<b>\$</b> 52,559	1.5	\$81,020		with guard	WC103	5.9
:-104	1	0	1st Shredder Conveyor	AREA0100	154	170	1.11	\$25,650	1999	\$25,650	0.6	\$27,235	1.5			60" wide x 25' long, 10 HP, TEFC drive with guard	WC104	5.8
-105	1	0	1st Infeed Belt	AREA0100	154	170	1.11	\$38,500	1999	\$38,500	0.6	\$40,879	1.5	\$63,015		60" wide x 30' long, 10 HP, TEFC drive with guard	WC105	11.9
C-106	1	0	2nd Shredder Conveyor 2nd Infeed Bell	AREA0100	154 154	170	1.11	\$29,500	1999	\$29,500	0.6 0.6	\$31,323	1.5	\$48,285		48" wide x 20' long, 7.5 HP, TEFC drive with guard	WC106	4.4
2-108	1	0	3rd Shredder Conveyor	AREA0100	154	170	1.11	\$27,500 \$29,500	1999	\$27,500 \$29,500	0.6	\$29,200	1.5	417		48" wide x 30' long, 5 HP, TEFC drive with guard  48" wide x 20' long, 10 HP, TEFC drive with guard	WC107	2.9
2-109	1	0	Feed Screw Conveyor	AREA0100	225,140	562,850	2.50	\$29,500	1999	\$29,500	0.6	\$31,323 \$54,932	1.5	\$48,285 \$86,351		14" dia, 250' long	WC108 WC109	5.9 53.7
A-101	2	0	Truck Scale	AREA0100	96	72	0.75	\$10,000	1999	\$20,000	0.6	\$16,829	1.5			96 deliveries /scale/12hr	-1000109	33.7
A-102	1	0	Receiving Pad	AREA0100	250,000	250,000	1.00	\$2,083,500	1999	\$2,083,500	0.6	\$2,083,500	1.0			250,000 ft2 concrete pad, 9" thick with drainage		
A-103	6	1	Front End Loader	AREA0100	159,948	159,948	1.00	\$156,000	1998	\$1,092,000	0.6	\$1,092,000	1.2	\$ 1,326,016		run on gasoline	┥ .	
A-104	3	0	Bale Breaker	AREA0100	154	170	1.11	\$250,000	1999	\$750,000	0.6	\$796,352	1.2	\$955,622		30 HP each	WM104	53.6
A-105	1	0	Primary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.2	\$135,444		250 HP, 1200 rpm, hammermill	WM105	149.1
<i>I</i> -106	1	0	Secondary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.5	\$169,304		250 HP, 1200 rpm, hammermill	WM106	149.1
A-107	1	0	Shred Bunker	AREA0100	600,000	600,000	1.00	\$700,000	1999	\$700,000	0.6	\$700,000	1.0	\$700,000		200x100x30ft bunker with three walls, 3 days shred storage	7	
<i>I</i> -108	1	0	Storm Runoff Pond	AREA0100	1,747,767	1,747,767	1.00	\$51,198	1998	\$51,198	0.6	\$51,198	1.0	\$51,198	\$ 51,808	200 x 150 x 8 ft, 240,000ft3		
										weighted averages:	0,60		1.13				7	499.6
100									ubtotal			\$5,418,705	_	\$6,146,434	\$5,433,414			
						20	x bq1000	.45 (current ye	ar coşt v	with area weighted-ave			1.3	\$3,181,636	(\$2,964,798)	is installed cost savings		
				,		,		,			Base Year≃	1999						
-201	!	0	In-line Sulfuric Acid Mixer	STRM0214	55,308	23,725	0.43	\$1,900		\$1,900	0.48	\$1,266	1.2	\$1,585		Static Mixer, 110 gpm total flow	4	
-202 -209	1	0	In-line NH3 Mixer Overliming Tank Agitator	STRM0244	53,630 167,050	18,317	0.34	\$1,500	1997	\$1,500	0.48	\$896	1.2	\$1,122		Static Mixer, 82 gpm total flow		
-224		0		STRM0228		102,608	0.61	\$19,800	1997	\$19,800	0.51	\$15,442	1.2	\$19,345		Top Mounted, 1800 rpm, 15 hp	WT209	8.3
-232		0	Reacidification Tank Agitator Resturrying Tank Agitator	STRM0239 STRM0250	167,280 358,810	102,752 167,795	0.61	\$65,200 \$36,000	1997	\$65,200	0.51 0.51	\$50,851	1.2	\$63,702		Top-Mounted, 1800 rpm, 54 hp	WT224	25.1
-235		0	In-line Acidification Mixer	STRM0236	164,570	101,104	0.47	\$2,600	1997 1997	\$36,000 \$2,600	0.51	\$24,432 \$2,058	1.2	\$30,606 \$2,578		Top-Mounted, 1800 rpm, 25 hp Static-Mixer, 440 gpm total flow	WT232	- 13,9
-201	1	0	Hydrolyzate Screw Conveyor	STRM0220	225,140	101,493	0.45	\$59,400	1997	\$59.400	0.48	\$31,908	1.5	\$50,158		18" dia. 33' long, 3420 cfh max flow, 23 hp	WC201	13.7
-202	1	0	Wash Solids Screw Conveyor	STRM0225	196,720	165,453	0.84	\$23,700	1997	\$23,700	0.70	\$19,933	1.5	\$31,334		18" dia: 16' long, 3420 cfh max flow	WC202	16.7
-225	- <del>i</del> -	0	Lime Solids Feeder	077(100223	130,720	0	0.04	\$3,900	1997	\$3,900	······································	\$3,900	1.5	\$6,131		6" dia., 63 cfh, 3150 lb/hr max flow	WC202	0.1
-200	1	0	Hydrolyzate Cooler	AREA0200	1,988	895	0.45	\$45,000	1997	\$45,000	0.51	\$29,947	2.2	\$66,543		Fixed Tube Sheet, 900 sf, 20" dia. X 20' long	-	۵.,
1-201	1	1	Beer Column Feed Economizer	AREA0201	5.641	5.641	1.00	\$139,350	1999	\$278,700	0.68	\$278,700	2.2	\$607,278		TEMA type AES shell and tube 5641 sf, 42" dia x 20" long	-	
1-202	1	0	Prehydrolysis Reactor	STRM0217	270,034	121,514		\$12,461,841	1998	\$12,461,841	0.78	\$6,684,746	1.5	\$10,146,612		Vertical Screw, 10 min residence time	WM105	353.1
-201	1	1	Sulfuric Acid Pump	STRM0710	1,647	414	0.25	\$4,800	1997	\$9,600	0.79	\$3,228	2.8	\$9,190		2 gpm, 245 ft, head	WP201	0.4
-209	Í	1	Overlimed Hydrolyzate Pump	STRM0228	167,050	102,608	0.61	\$10,700	1997	\$21,400	0.79	\$14,561	2.8	\$41,458		448 gpm, 150 ft. head	WP209	18.0
-222	1	1	Filtered Hydrolyzate Pump	STRM0230	162,090	101,614	0.63	\$10,800	1997	\$21,600	0.79	\$14,936	2.8	\$42,526	\$15,231	448 gpm, 150 ft head	WP222	17.8
-223	1	0	Lime Unloading Blower	STRM0227	547	337	0.62	\$47,600	1998	\$47,600	0.5	\$37,340	1.4	\$52,898	\$37,785	3341 cfm, 6 psi, 10,024 lb/hr	WP223	4.1
-224	1	1	Hydrolysis Feed Pump	STRM0250	160,000	167,795	1.05	\$64,934	1999	\$129,868	0.5	\$133,628	1.2	\$160,354	\$133,628	740 gpm, 240 ft head	WP224	119.3
-225	1	1	ISEP Elution Pump	STRM0243	52,731	18,005	0.34	\$7,900	1997	\$15,800	0.79	\$6,761	2.8	\$19,249	\$6,894	104 gpm, 150 ft head	WP225	3.9
-226	1	1	ISEP Reload Pump	STRM0246	164,D80	100,802	0.61	\$8,700	1997	\$17,400	0.79	\$11,841	2.8	\$33,714	\$12,075	445 gpm, 150 ft head	WP226	17.9
-227	1	11	ISEP Hydrolyzate Feed Pump	STRM0221	160,290	98,157	0.61	\$10,700	1997	\$21,400	0.79	\$14,526	2.8	\$41,359	\$14,814	432 gpm, 150 ft head	WP227	16.8
-239	1	11	Reacidified Liquor Pump	STRM0239	167,280	102,752	0.61	\$10,800	1997	\$21,600	0.79	\$14,698	2.8	\$41,847	\$14,988	450 gpm, 100 ft head	WP239	12.0
-202 -221	3	0	Pre-IX Belt Filter Press	SOLD0220	57,000	57,000	1.00	\$200,000	1998	\$600,000	0.39	\$600,000	1.4	\$850,010		Use 3 units for 45% of the flow as recommended by the vendor	WS202	19.6
	-!-	0	ISEP	STRM0240	210,005	98,157	0.47	\$2,058,000	1997	\$2,058,000	0.33	\$1,601,194	1.2	\$1,959,422		10 chambers (39" dia. X 84" high), 4" dia. Valve - Weak Base Resin	WS221	2.9
	1	0	Hydroclone & Rotary Drum Filter	STRM0229	5,195	1,137	0.22	\$165,000	1998	\$165,000	0.39	\$91,224	1.4	\$129,235		Hydrocyclone and Vacuum Filter for 453 gpm	WS222	11.9
-222		0	LimeDust Vent Baghouse Suffuric Acid Storage	STRM0227 STRM0710	548 1.647	337 860	0.61	\$32,200	1997	\$32,200	1	\$19,778	1.5	\$30,254		3750 cfm, 625 sf, 6 cfm/sf	-	
-222 -227					1647	I 860	0.52	\$5,760	1996	\$5,760	0.71	\$3,633	1.7	\$6,283	I <b>\$</b> 3,751	2000 gal., 24 hr. residence time, 90% wv, 5.5ft diam. X 11ft	The Control of	
-222 -227 -201	1	0															_	
-222 -227 -201 -203		0	Blowdown Tank	STRM0217	270,300	121,514	0.45	\$64,100	1997	\$64,100	0.93	\$30,475	1.7	\$52,061	\$31,078	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig	4 : -	
-222 -227 -201 -203 -209		0	Blowdown Tank Overtiming Tank	STRM0217 STRM0228	270,300 167,050	121,514 102,608	0.45 0.61	\$64,100 \$71,000	1997 1997	\$64,100 \$71,000	0.93 0.71	\$50,232	1.8	\$90,186	\$31,078 \$51,225	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig 29850 gal., 16' dia. X 32' high, 1 hr. res. time, 90% wv, 15 psig	]	
-222 -227 -201 -203 -209 -220		0 0 0	Blowdown Tank Overlinning Tank Lime Storage Bin	STRM0217 STRM0228 STRM0227	270,300 167,050 548	121,514 102,608 548	0.45 0.61 1.00	\$64,100 \$71,000 \$69,200	1997 1997 1997	\$64,100 \$71,000 \$69,200	0.93 0.71 0.46	\$50,232 \$69,200	1.8	\$90,186 \$124,243	\$31,078 \$51,225 \$70,568	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig 29850 gal., 16' dia. X 32' high, 1 hr. res. time, 90% wv, 15 psig 4455 cf, 14' dia x 25' high, 1.5x rail car vol., atmospheric, 15 day storage	пах	
-222 -227 -201 -203 -209		0	Blowdown Tank Overtiming Tank	STRM0217 STRM0228	270,300 167,050	121,514 102,608	0.45 0.61	\$64,100 \$71,000	1997 1997	\$64,100 \$71,000	0.93 0.71	\$50,232	1.8	\$90,186	\$31,078 \$51,225 \$70,568 \$111,889	7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig 29850 gal., 16' dia. X 32' high, 1 hr. res. time, 90% wv, 15 psig	nax	

\$14,955,166 \$10,128,493 Subtotal \$16,527,758 \$9,999,337 2000tpd x .45 (current year cost with area weighted-average scale exponent applied) 1.5 \$15,025,380 \$70,213 is installed cost savings

0.70

\$0

\$0 0

A200

0 0.00 \$0 1999

weighted averages:

\$0

676.27

	8	0	Fermentor Agitators	GALLONS	962,651	750,000	0.78	\$19,676	1996	\$157,408	0.51	\$138,592	1.2	\$175,799	\$143,110 Side Mounted, 2 per vessel, 60 hp each, 0.15 hp/1000 gal	WT300	:
31	1	0	Seed Hold Tank Agitator	STRM0304	41,777	17,529	0.42	\$12,551	1996	\$12,551	0.51	\$8,060	1.2	\$10,223	\$8,322 Top Mounted, 1800 rpm, 10 hp, 0.1 hp/1000 gal	WT301	
	2	0	4th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$11,700	1997	\$23,400	0.51	\$15,026	1.2	\$18,824	\$15,323 Top Mounted, 1800 rpm, 3 hp, 0.3 hp/1000 gal	WT304	
	2	Ð	5th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$10,340	1996	\$20,680	0.51	\$13,280	1.2	\$15,845	\$13,713 Top Mounted, 1800 rpm, 9 hp, 0.1 hp/1000 gal	WT305	
	1	0	Beer Well Agitator	STRM0502	381,700	173,737	0.46	\$10,100	1997	\$10,100	0.51	\$6,761	1.2	\$8,469	\$6,894 Top Mounted, 1800 rpm, 2 hp, 0.3 hp/1000 gal	WT306	
	4	0	Fermentors	GALLONS	750,000	750,000	1.00	\$326,203	1999	\$1,304,812	0.71	\$1,304,812	1.8	\$2,297,260	\$1,304,812 750,000 gal. each, 2 day residence total, 90% wv, API, atmospheric, 50' f x	x 51'	
	2	0	1st Fermentation Seed Fermentor	None		0	0.45	\$14,700	1997	\$29,400	0.93	\$13,991	2.8	\$39,948	\$14,267 9 gal, jacketed, agitated, 1' dia., 1.5' high, 15 psig	7	
	2	0	2nd Fermentation Seed Fermentor	None		0	0.45	\$32,600	1997	\$65,200	0.93	\$31,027	2.8	\$88,592	\$31,640 90 gal., jacketed, agitated, 2' 3" dia., 3' high, 2.5 psig	7	
	2	0	3rd Fermentation Seed Fermentor	None		0	0.45	\$81,100	1997	\$162,200	0.93	\$77,186	2.8	\$220,394	\$78,712 900 gal., jacketed, agitated, 5' dia, 6.5' high, 2.5 psig	7	
	2	0	4th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$39,500	1997	\$79,000	0.93	\$35,225	1.7	\$60,174	\$35,921 9000 gal., 9' dia x 19' high, almospheric	7	
	2	0	5th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$147,245	1998	\$294,490	0.51	\$189,107	1.8	\$336,910	\$191,360 90000 gat., API, atmospheric 25'f x 25'	-	
$\neg$	4	1	Fermentation Cooler	QHX300EA	67,820	25,053	0.37	\$4,000	1997	\$20,000	0.78	\$9,198	2.2	\$20,438	\$9,380 4 exchangers at 221 sf, U=300 BTU/hr sf F LMTD = 22.9°F plate and frame	럹	
	1	0	Fermentation Seed Hydrolyzate Coole	AREA0301	773	318	0.41	\$15,539	1998	\$15,539	0.78	\$7,778	2.2	\$17,151	\$7,871 348 sf. 300 BTU/hr sf F	7	
?	1	D	Fermentation Pre-Cooler	AREA0302	3,765	828	0.22	\$25,409	1998	\$25,409	0.78	\$7,797	2.2	\$17,193	\$7,890 828 sf lotal, plate and frame	-	
1	1	0	4TH Seed Fermentor Coils	QSDF0301	38,339	15,789	0.41	\$3,300	1997	\$3,300	0.83	\$1,580	1.2	\$1,934	\$1.611 12 sf. 1" sch 40 pipe, 105 BTU/hr sf F	-	
5	1	0	5TH Seed Fermentor Coils	QSDF0301	38,339	15,789	0.41	\$18,800	1997	\$18,800	0.98	\$7,881	1.2	\$9,644	\$8,037 138 sf, 2" sch 40 pipe, 92 BTU/hr sf F	-{	
,	4	1	Fermentation Recirc./Transfer Pump	QHX300EA	67.737	55,505	0.82	\$8,000	1997	\$40,000	0.79	\$34,177	2.8	\$97,307	\$34,852 844 gpm @ 150 ft sized based on heating rate	WP300	
1	1	1	Fermentation Seed Transfer Pump	STRM0304	41,777	17.529	0.42	\$22,194	1998	\$44,388	0.7	\$24,168	1.4	\$34,238	\$24,456 280 gpm @ 150 ft head	WP301	
2	2	0	Seed Transfer Pump	STRM0304	41.777	17,529	0.42	\$54,088	1998	\$108,176	0.7	\$58.898	1.4	\$83,440	\$59,600 504 gpm total, 252 gpm each, 100 ft head	WP302	
5	1	1	Beer Transfer Pump	STRM0502	381,701	173,737	0.46	\$17,300	1997	\$34,600	0.79	\$18,579	2.8	\$52,899	\$18,947 790 gpm each, 171 ft head	WP306	
1	1	0	Fermentation Seed Hold Tank	STRM0304	41,777	17.529	0.42	\$161.593	1998	\$161,593	0.51	\$103,767	1.8	\$184,870	\$105,003 105000 gal., API almospheric	- WP300	
6	1	0	Beer Well	STRM0502	129,000	183,467	1.42	\$111,889	1999	\$111,889	0.51	\$133,906	1.8	\$235,756	\$133,906 192,518 gal., 32' dia x 32' high, 4 hr, res, time, 95% wv, atmospheric		
				T CTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT	720,000	1_100,101	1	4111,000 1		veighted averages:	0.68	#133,300	1.79	\$233,730	\$155,500 [192,510 gail, 32 dia x 32 high, 4 hit. 185. linie, 95% wv. athlosphene	4	-
r								9	ubtotaf	\$2,742,935	0.00	\$2,240,795	1.73	\$4,028,307	\$2,255.629	ł	
						20	00lpd x .			ith area weighted-ave	rage scale exp		1.3	\$8,218,509	\$4,190,202 is installed cost savings		
	8	0	Enzymatic Hydrolysis Tank Agitators	STRM0302B	157,136	157,136	1.00			\$157,408	0.51	\$157,408	1.2	\$199,666	\$162,539 Iwo side mounted 75 hp agitators / tank, 0.4hp/1000 gal.	WT307	
	12	0	Enzymatic Hydrolysis Tank Heater	STRM0302B	157,136	157,136	1.00	\$15,000	1999	\$180,000	0.78	\$180,000	2.2	\$392,214	\$180,000 65 ft2 double pipe	1	
	1	0	Pre-hydrolyzate cooler	STRM0302	145,536	145,536	1.00	\$25,000	1999	\$25,000	0.78	\$25,000	2.2	\$54,474	\$25,000 481 ft2, paratlel double pipe	1	
8	8	1	Hydrolyzer Bottoms Pump	STRM0302B	157,136	157,136	1.00	\$121,690	1999	\$1,095,210	0.6	\$1,095,210	1.2	\$1,314,252	\$1,095,210 3000 GPM each Disc flow pumps, 245ft head	WP308	
	. 1	_				1		ı							375,000 gallons, 24 hour residence time, 2 side mounted agitators cone	7	
	4	0	Enzymatic Hydrolysis Tank	STRM0302B	750,000	375,000	0.50	\$326,203		\$1,304,812	0.5	\$860,855		\$1,753,728	\$860,855 bottom, concrete base, bottom outlet through the concrete, 300 cone	1	
0 1	o T									\$1,004,012			2.0	91,733,720		1	
	ــــــــــــــــــــــــــــــــــــــ	0	10	0	0	0	0.00		1999	\$0	0	\$0		\$1,733,720	\$0 0	1	
207	٠	0	10	0	0	0	0.00	\$0	v	\$0 veighted averages:		\$0		\$0	<b>5</b> 0 0	1	-
307		0	10	0	0	0	0.00	\$0		\$0	0						-
307		0	10.	0 [	0			\$0 S	ubtotal	\$0 veighted averages:	0.61	\$0 \$2,318,473		\$0	<b>5</b> 0 0		-
		0	10		0			\$0 S	ubtotal	\$0 veighted averages: \$2,762,430	0.61	\$0 \$2,318,473		\$0 \$3,714,334	\$0 0 \$2,323,604 (\$3,714,334) is installed cost savings	v consum	ned
	11	0	Cellulase Fermentor Agitators	GALLONS	150,000	20	00tpd x .	\$0 S	ubtotal	\$0 veighted averages: \$2,762,430	0.61 rage scale exp	\$0 \$2,318,473		\$0 \$3,714,334	\$0 0 \$2,323,604 (\$3,714,334) is installed cost savings \$475,868   sizes not updated to reflect 25% increase, but costs and energy	Consum WT400	
) 1		0	•	GALLONS	150,000	117,779.84	00tpd x	\$0 S 45 (current yea \$ 200,000	ubtotal ar cost w	\$0 veighted averages: \$2,762,430 ith area weighted-ave	0.61 rage scale exp	\$0 \$2,318,473 onent applied)	1.60	\$3,714,334 \$0	\$0 0 \$2,323,604 (\$3,714,334) is installed cost savings \$4475,868 Sizes not updated to reflect 25% Increase, but costs and energy \$1,944,743   125 hp / agitator - 1 agitator/vessel		
) 1	11	0	Cellulase Fermentor Agitators Cellulase Fermentors			20	00tpd x	\$0 S 45 (current yea	ubtotal ar cost w	\$0 veighted averages: \$2,762,430 ith area weighted-ave	0.61 rage scale exp	\$2,318,473 onent applied)	1.60	\$3,714,334 \$0 \$2,388,960	\$0 0  \$2,323,604  (\$3,714,334) is installed cost savings  \$475,868		
1		0	•	GALLONS	150,000	117,779.84	00tpd x	\$0 \$ \$45 (current yea \$ 200,000 \$ 179,952	ubtotal ar cost w	\$0 veighted averages: \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472	0 0.61 rage scale exp	\$2,318,473 onent applied) 1,944,743 5 2,428,040	1.60	\$3,714,334 \$0 \$2,388,960 \$4,325,765	\$0 0  \$2,323,604  (\$3,714,334) is installed cost savings \$475,868   Sizes not updated to reflect 25% Increase, but costs and energy \$1,944,743   125 hp / agitator 1 agitator/vessel 88335 gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20 \$2,456,975   ht. diameter		
) 1	11	0	Cellulase Fermentors	GALLONS GALLONS	150,000 88,335	117,779.84 117,779.84 1,242.43	0.79 0.79 1.33	\$0 \$ \$5 (current year \$ 200,000 \$ 179,952 \$ 22,500	ubtotal ar cost w 1999 1998 1997	\$0 veighted averages: \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500	0 0.61 rage scale exp	\$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810	1.60	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878	\$2,323,604 (\$3,714,334) is installed cost savings \$475,868 \$1289 not updated to reliect 25% Incresse, but costs and energy \$1,944,743   125 hp / agitator 1 agitator/vessel 88335 gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20 \$2,456,975   ft. diameter \$32,439   11 gal / 15 psig / Jacketed / Agitator	WT400	
) 1 ) 1	11 3	0	Cellulase Fermentors 1st Cellulase Seed Fermentor	GALLONS GALLONS STRM0433	150,000 88,335 2,790	117,779.84 117,779.84 1,242.43 1,242.43	0.79 0.79 1.33 0.45	\$0 \$ \$45 (current year \$ 200,000   \$ 179,952 \$ 22,500 \$ 54,100	1999 1998 1997	\$0 veighted averages: \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300	0 0.61 rage scale exp	\$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486	1.60 1.60 1.2 1.8 2.0 2.0	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996	\$0,00  \$2,323,604  (\$3,714,334) is installed cost savings  \$475,868		
) 1	11 3 3	0	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor	GALLONS GALLONS STRM0433 STRM0433 STRM0433	150,000 88,335 2,790 2,790 2,790	117,779.84 117,779.84 1,242.43 1,242.43 1,242.43	0.79 0.79 1.33 0.45 0.45	\$0 \$ 45 (current year \$ 200,000   \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100	1999 1998 1997 1997	\$0 veighted averages: \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300	0 0.61 rage scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$	\$2,318,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829	1.60 1.60 1.2 1.8 2.0 2.0 2.0	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429	\$0,00  \$2,323,604  (\$3,714,334) is installed cost savings  \$475,868	WT400	
) 1	11 3 3 3	1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Fermentation Cooler	GALLONS GALLONS STRM0433 STRM0433 STRM0433 QHX400EA	150,000 88,335 2,790 2,790 2,790 236,668	117,779.84 117,779.84 1,242.43 1,242.43 1,242.43 117,779.84	0.79 1.33 0.45 0.45 0.45 0.50	\$0 \$ \$45 (current year \$ 200,000   \$ 179,952   \$ 22,500   \$ 54,100   \$ 282,100   \$ 34,400	1999 1998 1997 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$378,400	0 0.61 age scale exp	\$0 \$2,318,473 onent applied) 1,944,743 5 2,428,040 31,810 31,810 76,486 398,829 219,562	1.60 1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.2	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,878	\$2,323,604 (\$3,714,334) is installed cost savings \$475,868 \$\frac{3714,334}{3714,334}\$ is installed cost savings \$475,868 \$\frac{3716}{3714,334}\$ is installed cost savings \$479,847,43 \$\frac{125 \text{ p/ agitator - 1 agitator/vessel}}{88335 \text{ gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20} \$2,456,975 it. diarmeter \$32,439 \$\frac{11}{3}\$ \$\frac{1}{3}\$ \$\frac{15}{3}\$ \$\frac{15}{3}	WT400	πed
1 1	11 3 3 3 3	1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package	GALLONS GALLONS STRM0433 STRM0433 GHX400EA STRM0440	150,000 88,335 2,790 2,790 2,790 236,668 80,455	117,779.84 117,779.84 1,242.43 1,242.43 1,242.43 117,779.84 107,273.33	0.79 1.33 0.45 0.45 0.45 0.50 1.33	\$0 \$ \$45 (current year \$ 200,000   \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 229,000	1999 1998 1997 1997 1997 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$378,400 \$1,374,000	0 0.61 age scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.34 \$	\$0 \$2,318,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,562 1,515,186	1.60 1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.2 1.3	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,678 \$19,69,742	\$2,323,604  (\$3,714,334) is installed cost savings \$475,868	WT400 WT402 WM401	
1 1	11 3 3 3 3 11	1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump	GALLONS GALLONS STRM0433 STRM0433 STRM0433 GHX400EA STRM0440 STRM0420	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543	117,779.84 117,779.84 1,242.43 1,242.43 1,242.43 1,7779.84 107,273.33 15,467.03	0.79 1.33 0.45 0.45 0.45 0.50 1.33 0.38	\$0 \$ 45 (current years) \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 229,000 \$ 9,300	1999 1998 1997 1997 1997 1997 1999 1997	\$0 veighted averages \$2,762,430 ith area weighted ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$378,400 \$1,374,000 \$1,600	0 0.61 rage scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.78 \$ 0.79 \$	\$0 \$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,562 1,515,186 8,687	1.60 1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.2 1.3 2.8	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,678 \$155,996 \$813,429 \$487,678 \$1,969,742 \$24,735	\$2,323,604  (\$3,714,334) is installed cost savings  \$475,868	WT400 WT402 WM401 WP400	πed
) 1 ) 1 : : : : : : : : : : : : : : : : : : :	111 3 3 3 3 111 5	1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Termentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Seed Pump	GALLONS GALLONS STRM0433 STRM0433 GHX400EA STRM0440 STRM0440 STRM0440 STRM0440 STRM0420	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543 2,790	117,779.84 117,779.84 11,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43	0.79 1.33 0.45 0.45 0.45 0.50 1.33 0.38 0.45	\$0 \$ 45 (current year \$ 200,000   \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 229,000 \$ 9,300 \$ 12,105	1999 1998 1997 1997 1997 1997 1999 1997 1998	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$346,300 \$374,000 \$1,374,000 \$1,374,000 \$24,210	0 0.61 rage scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.34 \$ 0.79 \$ 0.79 \$	\$0 \$2,318,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,562 1,515,186 8,687 13,742	1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.1 3 2.8 1.2	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,676 \$1,969,742 \$24,735 \$16,687	\$2,323,604  (\$3,714,334) is installed cost savings \$475,868 \$\frac{3728}{3728}\ \ not \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	WT400 WT402 WM401 WP400 WP401	πed
0 1 0 1 1 2 3 0 1 1 1 0	3 3 3 11 5 1	1 1 1 1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Seed Pump Media Pump	GALLONS GALLONS STRM0433 STRM0433 STRM0433 GHX400EA STRM0440 STRM0420 STRM0420 STRM0433 STRM0416	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543 2,790 586	117,779.84 117,779.84 11,242.43 11,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85	0.79 1.33 0.45 0.45 0.45 0.45 0.45 0.50 1.33 0.38 0.45 0.46	\$0 \$ \$200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 229,000 \$ 9,300 \$ 9,300 \$ 8,300	1999 1998 1997 1997 1997 1997 1997 1999 1997 1998 1997	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$378,400 \$1,374,000 \$18,600 \$24,210 \$16,600	0 0.61  rage scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.34 \$ 0.79 \$ 0.70 \$	\$0 \$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,562 1,515,186 8,687 13,742 8,917	1.60 1.2 1.8 2.0 2.0 2.0 2.2 1.3 2.8 1.2 2.8	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388	\$2,323,604  (\$3,714,334) is installed cost savings \$475,868	WT400 WT402 WM401 WP400 WP401 WP405	πεσ
) 1 ) 1 : : : : : : : : : : : : : : : : : : :	111 3 3 3 3 111 5 1 1 1	1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Gellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Seed Pump Media Pump Anti-loam Pump	GALLONS GALLONS STRM0433 STRM0433 STRM0433 GHX400EA STRM0420 STRM0420 STRM0420 STRM0416 STRM0416	150,000 88,335 2,790 2,790 236,668 80,455 40,554 2,790 586 227	117,779.84 117,779.84 1,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85 104.85	0.79 1.33 0.45 0.45 0.45 0.50 1.33 0.38 0.45 0.46	\$0 \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 29,000 \$ 12,105 \$ 3,300 \$ 12,105 \$ 5,500	1999 1998 1997 1997 1997 1997 1997 1999 1997 1998 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted averages \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$378,400 \$1,374,000 \$1,374,000 \$48,600 \$24,210 \$16,600 \$11,000	0 0.61  age scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.79 \$ 0.70 \$ 0.79 \$ 0.79 \$	\$0, \$2,316,473 onent applied) 1,944,743 5 2,426,040 31,810 76,486 398,829 219,562 1,515,186 6,667 13,742 8,917 5,976	1.60 1.8 2.0 2.0 2.0 2.2 1.3 2.8 1.2 2.8 2.8	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388 \$17,013	\$2,323,604  \$3,714,334) is installed cost savings \$475,868 \$1283 not updated to reflect 25% Incresse, but costs and energy \$1,944,743   125 hp / agitator 1 agitator/vessel  88335 gal, 2.5 psig, cooling cells in tank costed as H400, 40 ft. height, 20 \$2,456,975 ft. diameter \$32,439   11 gal / 15 psig / Jacketed / Agitator \$77,998   221 gal / 15 psig / Jacketed / Agitator \$77,998   221 gal / 15 psig / Jacketed / Agitator \$406,715   4417 gal / 15 psig / Jacketed / Agitator \$223,903   Immersible Coll 205 ft2 each \$1,515,186   7946 scfm each, 50 psig outlet, 1277 hp each, includes starter \$8,859   58 GPM / 100 ft. head \$13,906   24 gpm / 1 hp \$9,908   3 (5pm / 100 ft. Head \$6,094   4 gpm / 75 ft. head	WT402 WM401 WP400 WP401 WP405 WP420	nec
0 1 1 2 2 3 3 0 1 1 0 1 5 0 0	111 3 3 3 3 111 5 1 1 1 1	1 1 1 1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Teansfer Pump Media Pump Anti-foam Pump Media-Prep Tank	GALLONS GALLONS STRM0433 STRM0433 STRM0433 STRM0433 STRM0440 STRM0440 STRM0420 STRM0416 STRM0416 STRM0417	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543 2,790 586 227 586	117,779.84 117,779.84 1,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85 266.85	0.79 1.33 0.45 0.45 0.50 1.33 0.38 0.45 0.46 0.46 0.46	\$0 \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 282,000 \$ 34,400 \$ 229,000 \$ 9,300 \$ 12,105 \$ 8,300 \$ 6,600	1999 1998 1997 1997 1997 1997 1997 1999 1997 1998 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$374,000 \$1,374,000 \$18,600 \$24,210 \$16,600 \$11,000 \$54,600	0 0.61  age scale exp  0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$	\$0, \$2,316,473 onent applied) 1,944,743 5, 2,428,040 31,810 76,486 398,829 219,562 1,515,186 6,687 13,742 8,917 5,976 36,955	1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.1 3 2.8 1.2 2.8 2.8 1.7	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$13,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388 \$17,013 \$63,330	\$2,323,604  (\$3,714,334) is installed cost savings  \$475,868   Sizes not updated to reliect 25% Increase, but costs and energy \$1,944,743   125 hp / apilator - 1 agilator/vessel  88335 gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20 \$2,456,975 it. diameter  \$32,439   11 gal / 15 psig / Jacketed / Agilator  \$77,998   221 gal / 15 psig / Jacketed / Agilator  \$406,715   4417 gal / 15 psig / Jacketed / Agilator  \$223,903   Immersible Coil 205 ft2 each  \$1,515,186   7946 scfm each, 50 psig outlet, 1277 hp each, includes starter  \$8,859   58 GPM / 100 it. head  \$13,906   24 gpm / 1 hp  \$9,993   21 Gpm/100 Ft Head  \$6,094   4 gpm / 75 ft head  \$37,685   2083 Gal / 1.17 hp Agilator	WT400 WT402 WM401 WP400 WP401 WP405	nec
0 1 0 1 1 2 2 3 3 3 3 3 100 1 101 1 155 100 5	111 3 3 3 3 111 5 1 1 1	1 1 1 1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Gellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Seed Pump Media Pump Anti-loam Pump	GALLONS GALLONS STRM0433 STRM0433 STRM0433 GHX400EA STRM0420 STRM0420 STRM0420 STRM0416 STRM0416	150,000 88,335 2,790 2,790 236,668 80,455 40,554 2,790 586 227	117,779.84 117,779.84 1,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85 104.85	0.79 1.33 0.45 0.45 0.45 0.50 1.33 0.38 0.45 0.46	\$0 \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 282,000 \$ 34,400 \$ 229,000 \$ 9,300 \$ 12,105 \$ 8,300 \$ 6,600	1999 1998 1997 1997 1997 1997 1997 1999 1997 1998 1997 1998	\$0 veighted averages \$2,762,430 ith area weighted averages \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$378,400 \$1,374,000 \$1,374,000 \$48,600 \$24,210 \$16,600 \$11,000	0 0.61  age scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.74 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.71 \$ 0.71 \$ 0.71 \$ 0.71 \$	\$0 \$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,552 1,515,186 6,667 13,742 8,917 5,976 36,955 232	1.60 1.2 1.8 2.0 2.0 2.0 2.2 1.3 2.8 1.2 2.8 1.7	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388 \$17,013	\$2,323,604  \$3,714,334) is installed cost savings \$475,868 \$1283 not updated to reflect 25% Incresse, but costs and energy \$1,944,743   125 hp / agitator 1 agitator/vessel  88335 gal, 2.5 psig, cooling cells in tank costed as H400, 40 ft. height, 20 \$2,456,975 ft. diameter \$32,439   11 gal / 15 psig / Jacketed / Agitator \$77,998   221 gal / 15 psig / Jacketed / Agitator \$77,998   221 gal / 15 psig / Jacketed / Agitator \$406,715   4417 gal / 15 psig / Jacketed / Agitator \$223,903   Immersible Coll 205 ft2 each \$1,515,186   7946 scfm each, 50 psig outlet, 1277 hp each, includes starter \$8,859   58 GPM / 100 ft. head \$13,906   24 gpm / 1 hp \$9,908   3 (5pm / 100 ft. Head \$6,094   4 gpm / 75 ft. head	WT402 WM401 WP400 WP401 WP405 WP420	ned
0 1 0 1 1 2 3 3 00 1 01 1 15 5 0 0	111 3 3 3 3 111 5 1 1 1 1	1 1 1 1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Teansfer Pump Media Pump Anti-foam Pump Media-Prep Tank	GALLONS GALLONS STRM0433 STRM0433 STRM0433 STRM0433 STRM0440 STRM0440 STRM0420 STRM0416 STRM0416 STRM0417	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543 2,790 586 227 586	117,779.84 117,779.84 1,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85 266.85	0.79 1.33 0.45 0.45 0.50 1.33 0.38 0.45 0.46 0.46 0.46	\$0 \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 229,000 \$ 12,105 \$ 8,300 \$ 12,05 \$ 64,600 \$ 402	1999 1998 1997 1997 1997 1997 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted averages \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$1848,300 \$378,400 \$1,374,000 \$1,374,000 \$1,600 \$24,210 \$16,600 \$41,000 \$44,200	0 0.61  age scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.74 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.71 \$ 0.71 \$ 0.71 \$ 0.71 \$	\$0, \$2,316,473 onent applied) 1,944,743 5 2,426,040 31,810 76,486 398,829 219,562 1,515,186 13,742 8,917 5,976 36,955 232 install factor	1.60 1.2 1.8 2.0 2.0 2.0 2.0 2.1 3 2.8 1.2 2.8 2.8 1.7	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$813,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388 \$17,013 \$63,130 \$394	\$2,323,604  \$3,714,334) is installed cost savings \$475,868 \$123 not updated to reliect 25% Increase, but costs and energy \$1,944,743   125 hp / agitator 1 agitator/vessel  88335 gal, 2.5 psig, cooling cells in tank costed as H400, 40 ft. height, 20 \$2,456,975   ft. diameter  \$32,439   11 gal / 15 psig / Jacketed / Agitator  \$77,988   221 gal / 15 psig / Jacketed / Agitator  \$77,988   221 gal / 15 psig / Jacketed / Agitator  \$406,715   4417 gal / 15 psig / Jacketed / Agitator  \$233,903   \$1,515,186   7946 scfm each, 50 psig outlet, 1277 hp each, includes starter  \$8,895   58 GPM / 100 ft. head  \$13,906   24 gpm / 1 hp  \$9,903   2 Gpm/100 ft. Head  \$37,685   2083 Gal / 1.17 hp Agitator  \$235   67 gal, 3 hr. residence time	WT402 WM401 WP400 WP401 WP405 WP420	πεσ
0 1 0 1 1 2 2 3 3 0 1 1 1 9 0 1 1 5 0 0 5	111 3 3 3 3 111 5 1 1 1 1	1 1 1 1 1	Cellulase Fermentors 1st Cellulase Seed Fermentor 2nd Cellulase Seed Fermentor 3rd Cellulase Seed Fermentor Cellulase Seed Fermentor Cellulase Fermentation Cooler Fermentor Air Compressor Package Cellulase Transfer Pump Cellulase Teansfer Pump Media Pump Anti-foam Pump Media-Prep Tank	GALLONS GALLONS STRM0433 STRM0433 STRM0433 STRM0433 STRM0440 STRM0440 STRM0420 STRM0416 STRM0416 STRM0417	150,000 88,335 2,790 2,790 2,790 236,668 80,455 40,543 2,790 586 227 586	117,779.84 117,779.84 1,242.43 1,242.43 117,779.84 107,273.33 15,467.03 1,242.43 266.85 266.85	0.79 1.33 0.45 0.45 0.50 1.33 0.38 0.45 0.46 0.46 0.46	\$0 \$ 200,000 \$ 179,952 \$ 22,500 \$ 54,100 \$ 282,100 \$ 34,400 \$ 229,000 \$ 12,105 \$ 8,300 \$ 12,05 \$ 64,600 \$ 402	1999 1998 1997 1997 1997 1997 1997 1999 1997 1998 1997 1997	\$0 veighted averages \$2,762,430 ith area weighted-ave \$2,200,000 \$1,979,472 \$67,500 \$162,300 \$846,300 \$374,000 \$1,374,000 \$18,600 \$24,210 \$16,600 \$11,000 \$54,600	0 0.61  age scale exp 0.51 \$ 0.71 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.93 \$ 0.78 \$ 0.74 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.79 \$ 0.71 \$ 0.71 \$ 0.71 \$ 0.71 \$	\$0 \$2,316,473 onent applied) 1,944,743 5 2,428,040 31,810 76,486 398,829 219,552 1,515,186 6,667 13,742 8,917 5,976 36,955 232	1.60 1.2 1.8 2.0 2.0 2.0 2.2 1.3 2.8 1.2 2.8 1.7	\$0 \$3,714,334 \$0 \$2,388,960 \$4,325,765 \$64,878 \$155,996 \$13,429 \$487,678 \$1,969,742 \$24,735 \$16,687 \$25,388 \$17,013 \$63,330	\$2,323,604  (\$3,714,334) is installed cost savings  \$475,868   Sizes not updated to reliect 25% Increase, but costs and energy \$1,944,743   125 hp / apilator - 1 agilator/vessel  88335 gal, 2.5 psig, cooling coils in tank costed as H400, 40 ft. height, 20 \$2,456,975 it. diameter  \$32,439   11 gal / 15 psig / Jacketed / Agilator  \$77,998   221 gal / 15 psig / Jacketed / Agilator  \$406,715   4417 gal / 15 psig / Jacketed / Agilator  \$223,903   Immersible Coil 205 ft2 each  \$1,515,186   7946 scfm each, 50 psig outlet, 1277 hp each, includes starter  \$8,859   58 GPM / 100 it. head  \$13,906   24 gpm / 1 hp  \$9,993   21 Gpm/100 Ft Head  \$6,094   4 gpm / 75 ft head  \$37,685   2083 Gal / 1.17 hp Agilator	WT402 WM401 WP400 WP401 WP405 WP420	ned

-501	1 .	0	Beer Column	DIAMD501	4	2	0.56	\$636,976		\$636,976	0.78	\$402,792	2.1	\$873,434	\$415,921	7'6" DIA, 32 ACTUAL TRAYS, NUTTER V-GRID TRAYS	Ī	
-502	1	0	Rectification Column	S510S521	56,477	25,744	0.47	\$525,800	1996	\$525,800	0.78	\$293,491	2.1	\$636,421	\$303,058	8' dia.(rect)., 4' dia. (strip) x 18" T.S., 60 act. Trays, 60% eff., Nutter V-Grid	trays	
-501	1	0	1st Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,676	1996	\$435,676	0.68	\$435,676	2.1	\$944,742	\$449,877	22278 sf each., 135 BTU/hr sf F	Ì	
-502	1	0	2nd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.1	\$944,685		22278 sf., 170 BTU/hr sf F	1	
-503	1	0	3rd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650	2.1	\$944,685	\$449,850	22278 sf each., 170 BTU/hr sf F	ì	
1-501	- 1	0	Beer Column Reboiler	QRFD0501	-7,863,670	-3,723,722	0.474	\$158,374	1996	\$158,374	0.68	\$95,263	2.2	\$214,340	\$98,368	Fixed TS, 6602 sf, 31" dia., 20' long, 178 BTU/hr sf F	1	
1-502	1	0	Rectification Column Reboiler	QRFD0502	-987,427	-467,581	0.474	\$29,600	1997	\$29,600	0.68	\$17,805	2.2	\$39,563	\$18,157	Thermosyphon, 512 sf, 15" dia., 20' long, 130 BTU/hr sf F	1	
1-504	1	0	Beer Column Condenser	QCND0501	277,820	131,557	0.474	\$29,544	1996	\$29,544	0.68	\$17,771	2.2	\$39,984	\$18,350	Floating Head, 418 sf, 15" dia., 22' long, 92 BTU/hr sf F	1	
1-505	1	0	Rectification Column Condenser	QCND0502	4,905,410	2,322,883	0.474	\$86,174	1996	\$86,174	0.68	\$51,834	2.2	\$116,626	\$53,524	Fixed TS, 1969 sf, 29" dia, 20' long, 157 BTU/hr sf F	1	
1-512	1	1	Beer Column Feed Interchange	AREA0512	909	430	0.474	\$19,040	1996	\$38,080	0.68	\$22,905	2.2	\$51,537	\$23,652	431 sf, 200 BTU/hr sf F	1	
1-517	1	1	Evaporator Condenser	QHET0517	6,764,222	3,203,095	0.47	\$121,576	1996	\$243,152	0.68	\$146,257	2.2	\$329,077	\$151,024	Fixed TS, 3906 sf, 29" dia., 20' long, 220 BTU/hr sf F	1	
							1									Superheater, twin mole sieve columns, product cooler, condenser, pumps,	İ	
A-503	1	0	Molecular Sieve (9 pieces)	STRM0515	20.491	9,703	0.47	\$2,700,000	1998	\$2,700,000	0.7	\$1,599,964	1.0	\$1,619,030	\$1,619,030	vacuum source.	WM503	55
-501	1	1	Beer Column Bottoms Pump	P501FLOW	5,053	2,200	0.44	\$42,300	1997	\$84,600	0.79	\$43,861	2.8	\$124,881	\$44 728	2200 gpm, 150 ft head	WP501	84
2-503	1	1	Beer Column Reflux Pump	QCND0501	277,820	131,557	0.47	\$1,357	1998	\$2,714	0.79	\$1,504	2.8	\$4,248		6 gpm, 140 ft head	WP503	0
-504	1	1	Rectification Column Bottoms Pump	STRM0516	31,507	15.530	0.49	\$4,916		\$9,832	0.79	\$5,622	2.8	\$15,884		76 gpm, 158 ft head	WP504	2
-505	1	1	Rectification Column Reflux Pump	QCND0502	4,906,301	2,323,304	0.47	\$4,782	1998	\$9,564	0.79	\$5,299	2.8	\$14,970		207 gpm, 110 ft head	WP505	5
2-511	2	1	1st Effect Pump	STRM0525	278.645	133,617	0.48	\$19,700	1997	\$59,100	0.79	\$33,069	2.8	\$94,155		1137 gpm each, 110 ft head	WP511	67
2-512	1	1	2nd Effect Pump	STRM0528	91,111	45,390	0.50	\$13,900	1997	\$27,800	0.79	\$16,032	2.8	\$45,646		599 gpm, 110 ft head	WP512	17
2-513	2	1	3rd Effect Pump	STRM0531	48,001	23,814	0.50	\$8,000	1997	\$24,000	0.79	\$13,795	2.8	\$39,276		196 gpm each, 110 ft head	WP513	12
-514	1	1	Evaporator Condensate Pump	STRM534A	140,220	69,285	0.49	\$12,300	1997	\$24,600	0.79	\$14,095	2.8	\$40,131		293 gpm, 125 ft head	WP514	',
-515	<u> </u>		Scrubber Boltoms Pump	STRM0551	15,377	7,427	0.48	\$2,793	1998	\$5.586	0.79	\$3,143	2.8	\$8.881		31 gpm, 104 ft head	WP515	
2-517			Kill Tank Bottoms Pump	STRM0518	5.053	660	0.13	\$42,300	1997	\$84,600	0.79	\$16,944	2.8	\$48,242		660gpm, 72 ft head	WP517	12
-503		0	Beer Column Relfux Drum	QCND0501	277,820	131,557	0.47	\$11,900	1997	\$11,900	0.79						WP317	12
r-505		0	Rectification Column Reflux Drum	QCND0502	4,906,301	2.323.304		\$45,600				\$5,938	1.7	\$10,144		164 gal, 15 min res. Time, 50% wv, 2'6" dia., 5' long, 25 psig	l	
T-512		0					0.47		1997	\$45,600	0.72	\$26,621	1.7	\$45,476		6225 gal, 15 min res time, 50% wv, 7' dia, 22' long, 25 psig	l	
T-513	-1		Vent Scrubber Kill Tank	STRM0523	18,523	9,788	0.53	\$99,000	1998	\$99,000	0.78	\$60,197	1.7	\$102,043		5' dia x 25' high, 4 stages, plastic Jaeger Tri-Packing	ł	
1.010		0	Millank	STRM0518	149,897	149,897	1.00	\$99,920	1999	\$99,920	0.78	\$99,920	1.7	\$167,384	\$99,920]	18 psig, 30 min. res. time	j	
450D								_		weighted averages:	0.72		1.7					267
4300									Subtotal	. ,		\$4,301,097		\$7,515,486	\$4,400,972			
						20	oolpa x	.45 (current ye	ar cost v	vith area weighted-aver	rage scale ex	ponent applied)	1.7	\$6,765,614	-\$749,872	is installed cost savings		
-601	1	0	Lignin conveyor	STRM0601B	225,140	225,140	1.00	\$31,700	1997	\$31,700	0.60	\$31,700	1.5	\$49,832	\$32,327	14" dia. 100' long	WC109	21
A-613	1	0	Syrup Sprayer	STRM0531	22,372		1.00	\$1,000	1999	\$1,000	0.3	\$1,000	1.2	\$1,200		100 GPM syrup sprayer	1	
1-614	1	0	Lignin Loadout	STRM0601A	63,778	0	0.00	\$41,200	1999	\$41,200	0.3	\$0	1.0	\$0		245 GPM @ 20.6% insoluble solids	1 .	
				1		1				177,232				***		no less than 500,000 gal., above-ground bolled tank with cover, including	1	
1-615	1	0	Equalization Basin	STRM0830	98,267	102,204	1.04	\$350,000	1999	\$350,000	0.79	\$361,031	1.0	\$361,031		foundations, pumps and controls	WM615	1.077
A-616	1	0	Anaerobic Digestion System	STRM0830	98,267	102,204	1.04		1999	\$3,200,000	0.79	\$3,300,852	1.0	\$3,300,852		500,000 gal., includes site work, foundations, reactors and ancillary equipm		
		<u>`</u>	, macross Digestion System	101111111111111111111111111111111111111	30,207	102,204	1.07	\$3,200,000	1333	\$5,200,000		\$5,500,052	1.0	\$3,300,032		four-350,000 gal, Sequencing Batch Reactors, 48,000 lbs/day of O2	Î	
1	- 1					1							-			transfer capability, de-nitrification facilities, aeration and mixing requires	!	
A-617	1	0	Aerobic Digestion System	STRM0830	98.267	102,204	1.04	\$4,300,000	1000	\$4,300,000	0.79	\$4,435,520	1.0	\$4,435,520		approximately 1.400 horsepower	Į ·	
71.017		<u>-</u> _	Actubic Digestion System	311/1/10030	90,207	102,204	1.04	\$4,300,000	1999	\$4,300,000	0.79	34,435,520	1.0	34,433,320		400 ft2 of filtration surface area, includes the engineering and legal cost to	ł	
N-618		n	Pressure Sand Filters	STRM0830	98,267	102,204	1	*290.000	1000	•200,000	0.70	*200 005	4.0	*200 025				
2-630		1	Recycle Water Pump	STRM0602			1.04	\$280,000		\$280,000	0.79	\$288,825	1.0	\$288,825		acquire an NPDES permit		
					179,446	84,120	0.47	\$10,600	1997	\$21,200	0.79	\$11,652	2.8	\$33,175		370 gpm, 150ft head	WP630	14
6-601	2	0	Beer Column Bottoms Centrifuge	CENTFLOW	404	300	0.74	\$659,550	1998	\$1,319,100	0,6	\$1,103,371	1.2	\$1,339,824		requires 540gpm duty, 2 @ 300 gpm and 410 hp each	WS601	48
-630	1	0	Recycled Water Tank	STRM0602	179,446	84,120	0.47	\$14,515	1998	\$14,515	0.745	\$8,254	1.7	\$13,992	\$8,353	7410 gal, 20 min. res., 2.5 psig, 9.5ft diam. x 14.25ft		
										weighted averages:	0.7609184		1.0					1,602
4600								S	ubtotal	\$9,558,715		\$9,542,206		\$9,824,251	\$9,556,310			
						20	x bq1000	.45 (current ye	ar cost v	vith area weighted-aver	age scale ex	ponent applied)	1.3	\$5,157,342	(\$4,656,910)	is installed cost savings		
						20	oolpd x	.45 (current ye	ar cost v	vith area weighted-aver	age scale ex	ponent applied)	1.3	\$5,167,342	(\$4,656,910)	is installed cost savings		

Equi,

P-703	1	. 1	Sulfuric Acid Pump	STRM0710	1,647	1,912	1.16	\$8,000	1997	\$16,000	0.79	\$18,001	2.8	\$51,252	\$18,357 215 gpm, 150ft head	WP703	
P-707	1	1	Antifoam Store Pump	STRM0417	227	105	0.46	\$5,700	1997	\$11,400	0.79	\$6,193	2.8	\$17,633	\$6,315 0.5 gpm, 92 ft head	WP707	0.01
P-720	1	1	CSL Pump	STRM0735	2,039	859	0.42	\$8,800	1997	\$17,600	0.79	\$8,889	2.8	\$25,309	\$9,065 182 gpm, 150ft head	WP720	0.15
T-703	1		Sulfuric Acid Storage Tank	STRM0710	1,647	1,912	1.16	\$42,500	1997	\$42,500	0.51	\$45,860	1.8	\$82,338	\$46,767 20,000 gaf, 240 hr supply, 90% wv, 12ft diam. x 24 ft, atmospheric		
T-707	1		Antifoam Storage Tank	STRM0417	227	303	1.33	\$14,400	1997	\$14,400	0.71	\$17,663	1.7	\$30,174	\$18,012 12,000 gal, 27 day supply, 10.5ft diam. X 18.5ft	7	
T-720	1		CSL Storage Tank	STRM0735	2,039	859	0.42	\$88,100	1997	\$88,100	0.79	\$44,495	1.7	\$76,011	\$45,375 30160 gal, 90% wv, 120 supply, 14.3ft diam. X 25 ft	-1	
										*	are	ea install factor	2.0				0.28
A700								5	ubtotal	\$190,000		\$141,101		\$282,716	\$143,891	•	
						20	001pd x	.45 (current ye	ar cost v	with area weighted-ave	rage scale ex	xponent applied)	1.5	\$2,171,166	\$1,888,451 is installed cost savings		
			T	STRM0815 +		I								I	200,000 #/hr running @ 171,488 #/hr; with 40,000 #/hr 1600 superheat;	7	
M-803	1	0	Boiler with Superheater	216	200,000	200,000	1.00	\$1,590,000		\$1,590,000	0.7	\$1,590,000	1.3	\$2,067,000	\$1,590,000 132,000#/hr 390o sat. @ 205 psig	WM803	75.60
M-820	1	0	Hot process water softener system	STRM08118	229,386		0.20	\$1,383,300	1999	\$1,383,300	0.6	\$520,623	1.2	\$624,748	\$520,623 200 gpm	_	
M-830	_1_1	0	Hydrazine Addition Pkg.	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal lank, agilator, 2 melering pumps	WM830	10.00
M-832	_1	0	Ammonia Addition Pkg	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal tank, agitator, 2 metering pumps	WM832	10.00
M-834	1 1	0	Phosphate Addition Pkg.	STRM813A	229,386	80,536	0.35	\$19,000	1994	\$19,000	0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal tank, agitator, 2 metering pumps	WM834	10.00
P-804	2	1	Condensate Pump	STRM811A	249,633	38,798	0.16	\$7,100	1997	\$21,300	0.79	\$4,894	4.6	\$22,958	\$4,991 130 gpm, 150' head	WP804	9.21
P-824	2	1_	Deaerator Feed Pump	STRM811A	196,000	38,798	0.20	\$9,500	1997	\$28,500	0.79	<b>\$</b> 7,927	8.3	\$67,097	\$8,084 180 gpm, 115' head	WP824	4.89
P-826	4	1	BFW Pump	STRM0813	207,310	80,536	0.39	\$52,501	1998	\$262,505	0.79	\$124,377	1.4	\$176,203	\$125,859 310 gpm, 2740' head	WP826	400.99
P-828	_1	1	Blowdowл Pump	STRM0821	6,600	2,699	0.41	\$5,100	1997	\$10,200	0.79	\$5,032	6.4	\$32,842	\$5,132 12 gpm, 150' head	WP828	0.42
P-830	1	1	Hydrazine Transfer Pump	STRM813A	229,386	80,536	0.35	\$5,500	1997	\$11,000	0.79	\$4,811	6.4	\$31,402	\$4,907 3 gpm, 75' head	WP830	0.05
T-804	1	0	Condensate Collection Tank	STRM811A	229,386	38,798	0.17	\$7,100	1997	\$7,100	0.71	\$2,011	3.3	\$6,766	\$2,050 200 gal, 1.5 min. res. time	7	
T-824	1	0	Condensate Surge Drum	STRM811A	150,000	38,798	0.26	\$49,600	1997	\$49,600	0.72	\$18,734	5.0	\$95,523	\$19,105 2100 gal., 6' diam. X 10', 15 psig, res. time 11 min.	7	
T-826	1 1	0	Deaerator	STRM0813	267,000	80,536	0.30	\$165,000	1998	\$165,000	0.72	\$69,616	6.5	\$457,896	\$70,446 3030 gal., 15 psig, 10 min. res.	7	
T-828	1	D	Blowdown Flash Drum	STRM0821	6,550	2,699	0.41	\$9,200	1997	\$9,200	0.72	\$4,859	7.3	\$36,168	\$4,955 210 gal., 2.5' diam. X 6', 50 psig 17 min. res.	1	
T-830	1	0	Hydrazine Drum	STRM813A	229,386	80,536	0.35	\$12,400	1997	\$12,400	0.93	\$4,685	7.0	\$33,440	\$4,777 138 gal, 3.75' x 1.25' diam., 10 psig	1	
										weighted averages:	0.6704429		1.5			٦.	521.16
Q08A								S	ubtotal	\$3,607,105		\$2,387,986		\$3,684,612	\$2,393,497	,	
						20	001pd x .	45 (current yea	ar cost v	vith area weighted-ave	rage scale ex	(ponent applied)	1.1	\$23,046,972	\$19,362,360 is installed cost savings		
M-902	1	0	Cooling Tower System	QCWCAPIT	41,100,000	12,955,985		\$1,659,000	1998	\$1,659,000	0.78	\$674,181	1.2	\$818,659	\$682,216 49,000 gpm, 185.4MM BTU/hr	WM902	298.85
M-904	1	0	Plant Air Compressor	STRM0101	159,950		1.00	\$60,100	1997	\$60,100	0.34	\$60,100	1.3	\$79,675	\$61,288 450 cfm, 125 psig outlet	WM904	186.40
M-908	1	0	Chilled Water Package	QCHLWCAP	5,040,000	2,268,000	0.45	\$380,000	1997	\$380,000	0.8	\$200,610	1.2	\$245,492	\$204,577 1000 ton, 600kW	WM908	600.00
M-910	1	0	CIP System	STRM0914	63	28	0.45	\$95,000	1995	\$95,000	0.6	<b>\$</b> 58.837	1.2	\$73,021	\$60,851 designed by Delta-T, (est 0.2 kW)	WM910	0.20
P-902	1	1	Cooling Water Pumps	STRM0940	18,290,000	5,553,791	0.30	\$332,300	1997	\$664,600	0.79	\$259,201	2.8	\$737,993	\$264,326 12300 gpm, 70ft head	7	
P-912	_ 1	1	Make-up Water Pump	STRM0904	244,160	82,445	0.34	\$10,800	1997	\$21,600	0.79	\$9,161	2.8	\$26,084	\$9,343 370 gpm, 75ft head	WP912	7.32
P-914	1	1	Process Water Circulating Pump	STRM0905	352,710	111,503	0.32	\$11,100	1997	\$22,200	0.79	\$8,938	2.8	\$25,449	\$9,115 745 gpm, 75ft head	WP914	14.78
S-904	1	1	Instrument Air Dryer	STRM0101	159,950	71,977	0.45	\$15,498	1999	\$30,996	0.6	\$19,197	1.3	\$24,956	\$19,197 134 scfm air dryer, -40F Dewpoint	WS601	4.91
T-904	1	0	Plant Air Receiver	STRM0101	159,950	53,316	0.33	\$13,000	1997	\$13,000	0.72	\$5,894		\$10,069	\$6,011 300 gat., 200 psig	7	
T-914	1	0	Process Water Tank	STRM0905	352,710	111,503	0.32	\$195,500	1997	\$195,500	0.51	\$108,663	1.7	\$195,095	\$110,811 234360 gal, 8hr res. time	1	
									-	weighted averages:	0.751991		1.57		400 gpm well pump, 500ft head	53.16	1,165.62
Area 900								s	ubtotal	\$3,141,996		\$1,404,783		\$2,236,491	\$1,427,733	Total kw	14,823
						200	00tpd x .	45 (current yea	ar cost w	vith area weighted-ave	rage scale ex	(ponent applied)	1.3	\$5,278,320	\$3,041,829 is installed cost savings		

1	PLANT TOTAL:	\$44,443,856	\$62,741,793
ı	45% NREL TOTAL:	그는 이 그는 그리고 이 이번 할때 아이들은 이 이어에 대한 소문을 갖춘 중에 가는 것들은 것을 하는 것을 보면했다. 그는 것	\$79,208,934
	SAVINGS:	(do to much cheaper boiler and effect of separation of hydrolysis and fermentation)	\$16,467,141
ı			20.799

# TUDY MODEL WITH REFRENCE MODEL CELLULASE PRODUCTION: CELLULASE PRODUCTION COST (as prorated based on fraction of liquor requ CAPITAL INVESTMENT ASSUMPTIONS

	Net Capital Investment		\$15,846,807	
FEDERAL & STATE GRANTS	10%		(\$1,760,756)	
	Total Plant Cost		\$17,607,563	•
Working Capital per estimate			\$123,114 1	mos Raw matls. + O&M
Start-up, Permits, Fees	3.0%		\$378,725	
Contingency	10.0%		\$1,262,415	
Home Office Constr. Fee	12.0%		\$1,514,898	
Field Expense	8.0%		\$1,009,932	
Process Development	2.0%		\$252,483	
INDIRECTS Prorateable	3.5%	* *******	\$441,845	
Fixed Capital		\$	12,624,151	
Area 900		\$	38,945	estimated
Area 800		\$	64,163	
Area 700		\$	176,840	
Area 600		\$	430,086	
Area 500		\$	· · ·	
Area 400		\$	10,353,995	
Area 307		\$	~	
Area 300		\$	, <u>.</u>	
Area 200		\$	751,332	
Area 100		\$	308,790	
Civil Structural		\$	500,000	estimated
Total capital investment				

OPE	ERATING COST ASSUMPTIONS	<b>8,400</b> hr	/yr			
		<u>Amount/hr</u>	<u>Units</u>	\$/unit	Cost /hr.	Total Cost /yr
	Electricity	7,910	Kw-hr	\$0.035	\$277	\$2,325,687
	well water	Ō	kg	\$0.000	\$0	\$0
	Wastewater	2,977	kg	\$0.00026	\$1	\$6,605
	gypsum waste disposal (\$33/std	on) 57	kg	\$0.0364	\$2	\$17,449
	Total Utilities				\$280	\$2,349,741
	Raw Material Costs					
		Amount/hr	<u>Units</u>	\$/unit	Cost /hr.	Total Cost /yr
	Corn Stover DRY (stm 101 less water)	1,884	kg	\$0.016	\$30.01	\$252,113
	Sulfuric Acid (stm 710)	43	kg	\$0.100	\$4.33	\$36,403
	Calcium Oxide (Lime stm 227)	17	kg	\$0.293	\$4.96	\$41,650
	Ammonia (stm 717)	73	kg	\$0.162	\$11.86	\$99,586
	Corn Steep Liquor (stm 735)	200	kg	\$0.051	\$10.21	\$85,801
	Nutrients	80	kg	\$0.291	\$23.31	\$195,794
	Cellulase Complex	0	kg	\$3,000	\$0.00	\$0
	Natural Gasoline (stm 701)	0	kg	\$0.155	\$0.00	\$0
	Diesel/Gasoline	4	kg	\$0.155	\$0.62	\$5,198
	WWT Chemicals	0.2	kg	\$2.237	\$0.52	\$4,404
	CW Chemicals	0.3	kg	\$1.428	\$0.42	\$3,566
	BFW Chemicals	1.3	kg	\$0.226	\$0.29	\$2,435
	Boiler Fuel (stm 813)	3	Mbtu	\$2.500	\$8.29	\$69,637
	Total Raw Materials				\$95	\$796,588

# \$per lb. calcs.

Processing Material Costs							
Trocessing Material Gosts	<u>Amount/hr</u>	<u>Units</u>	3	\$/unit	Cos	t /hr.	Total Cost /yr
Antifoam (Corn Oil)	105	kg	\$	0.304		\$32	\$267,948
Total Processing Materials						\$32	\$267,948
Operations and Maintenance Costs - DRY HANDL	ING (area 100)	each/day	,	wage	hr/day each		Total Cost /yr.
Supervisors		0.025	\$	20.00	12		\$2,200
Operators		0.100	\$	16.00	12		\$7,041
Laborers		0.402	\$	16.00	12		\$28,166
Maintenance		0.100	\$	16.00	12		\$7,041
0							
Operations and Maintenance Costs - HYDROLYS	ISFERMENTATION						***
Supervisors		0.0	\$	20.00	12		\$2,200
Operators		0.2	\$	16.00	8		\$7,041
Laborers		0.1	\$	16.00	8		\$2,347
Technicians (Includes Lab.)		0.2	\$	16.00	8		\$7,041
Maintenance		0.2	\$	16.00	8		\$7,041
Operations and Maintenance Costs - Utilities (area	700 800 900)						
Supervisors	1700, 000, 0007	0.0	\$	20.00	12		\$1,100
Operators		0.2	\$	16.00	8		\$3,521
Laborers		0.1	\$	16.00	8		
Technicians		0.1	\$	16.00	8		\$1,174
Maintenance		0.1	\$		8		\$1,174
	Total Operations and			16.00	8		\$2,347 \$79,437
	otal operations and	a maintenance	labor co	7513			ψ15, <del>4</del> 51
Other Operations and Maintenance Costs							
Payroll Overhead	35% of operating lab	or				\$	27,803
Maintenance Costs	2% of plant cost					\$	252,483
Operating Supplies	0.25% of plant cost					\$	31,560
Environmental	0.50% of plant cost					\$	63,121
Local Taxes	1% of plant cost					\$	126,242
Insurance	0.50% of plant cost					\$	63,121
	10% of labor, super	vision,maint co	st .			\$	31,775
	1% of annual sales (					\$	5,239
	).5% of annual sales	•	,			\$	-
Total O&M Costs							\$680,780
perating Expenses							

Operating Expenses:		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Utilities		2,349,741
Raw Materials		796,588
Processing Materials	•	267,948
Operation & Mainten	ance	680,780
Property Tax @	0.50% Book Value	79,234
Depreciation		1,056,454
Debt retierment		1,418,471
Total Operating I	Expense (\$/vr)	\$6.649.217

#### \$per lb. calcs.

# HIGH PLAINS YORK CELLULASE PRODUCTION WITH PURVISION TECHNOLOGY (as prorated based on fraction of liquor required) CAPITAL INVESTMENT ASSUMPTIONS

CAF	PITAL INVESTMENT ASSUMPT	IONS					
1)	Total capital investment						
	Civil Structural		\$	500,000	estimated		
	Area 100		\$	204,724			
	Area 200		\$	381,629	•		
	Area 300		\$	_			
	Area 307		\$	· _			
	Area 400		\$	5,692,516			
	Area 500		\$	_			
	Area 600		\$	313,763			
	Area 700		\$	122,171			
	Area 800		\$				
	Area 900		\$	18,646	estimated		
	Fixed Capital		\$	7,264,708			
	INDIRECTS Prorateable	3.5%	throng	\$254,265			
	Process Development	2.0%		\$145,294			
	Field Expense	8.0%		\$581,177			
	Home Office Constr. Fee	12.0%		\$871,765			
	Contingency	10.0%		\$726,471			
	Start-up, Permits, Fees	3.0%		\$217,941			
	Working Capital per estimate		57.7 3.30	\$84,188	1 mos Raw matls.	+ O&M	
	- , ,	Total Plant Cost	Nie	\$10,145,809			
	FEDERAL & STATE GRANTS	10%	- WALK	(\$1,014,581	)		
		Net Capital Inve	stment	\$9,131,228			
OPE	ERATING COST ASSUMPTIONS	s 🥛	8,400 hr	/yr			
			Amount/hr	<u>Units</u>	<u>\$/unit</u>	Cost /hr.	Total Cost /yr
	Electricity		5,918	Kw-hr	\$0,035	\$207	\$1,739,954
	well water		0	kg	\$0.000	\$0	\$0
	Wastewater		2,232	kg	\$0.00026	\$1	\$4,954
	gypsum waste disposal	(\$33/ston)	43	kg	\$0.0364	\$2	\$13,087
							***************************************
	Total Utilities					\$209	\$1,757,995
	Raw Material Costs						
			Amount/hr	<u>Units</u>	\$/unit	Cost /hr.	Total Cost /yr
	Corn Stover DRY (stm 101 les	ss water)	1,413	kg	\$0.016	\$22.51	\$189,083
	Sulfuric Acid (stm 710)		32	kg	\$0.100	\$3.25	\$27,302
	Calcium Oxide (Lime stm 227)	)	13	kg	\$0.293	\$3.72	\$31,237
	Ammonia (stm 717)		57	kg	\$0.162	\$9.30	\$78,093
	Corn Steep Liquor (stm 735)		151	kg	\$0.051	\$7.69	\$64,629
	Nutrients		60	kg	\$0.291	\$17.48	\$146,846
	Cellulase Complex		0	kg	\$3.000	\$0.00	\$0
	Natural Gasoline (stm 701)		0	kg	\$0.155	\$0.00	\$0
	Diagol/Capalina		2	1	60.455	20.40	** ***

3

0.0

0.0

0.0

2

kg

kg

kg

kg

Mbtu

\$0.155

\$2.237

\$1.428

\$0.226

\$2.500

\$0.46

\$0.00

\$0.00

\$0.00

\$6.22

\$71

\$3,899

\$52,227

\$593,315

\$0

\$0

\$0

Processing Material Costs

Boiler Fuel (stm 813)

**Total Raw Materials** 

Diesel/Gasoline

WWT Chemicals

CW Chemicals

**BFW Chemicals** 

\$per lb. calcs.

	· ·	PP 10. 00100	•				
	Amount/hr	<u>Units</u>		\$/unit	Cost	/hr.	Total Cost /yr
Antifoam (Corn Oil)	79	kg		\$0.441		\$35	\$291,248
Total Processing Materials					:	\$35	\$291,248
Operations and Maintenance Costs - DRY HAND	LING (area 100)	each/day		wage	hr/day each		Total Cost /yr.
Supervisors		0.019	\$	20.00	12		\$1,650
Operators		0.075	\$	16.00	12		\$5,281
Laborers		0.301	\$	16.00	12		\$21,124
Maintenance		0.075	\$	16.00	12		\$5,281
Operations and Maintenance Costs - HYDROLYS	IS/FERMENTATIO	N (area 200, 30	00, 40	0, 500, 600)			
Supervisors		0.0	\$	20.00	12		\$1,650
Operators		0.1	\$	16.00	8		\$5,281
Laborers		0.0	\$	16.00	8		\$1,760
Technicians (Includes Lab.)		0.1	\$	16.00	8		\$5,281
Maintenance		0.1	\$	16.00	8		\$5,281
Operations and Maintenance Costs - Utilities (are	a 700. 800. 900)						
Supervisors		0.0	\$	20.00	12		\$825
Operators		0.1	\$	16.00	8		\$2,641
Laborers		0.0	\$	16.00	8		\$880
Technicians		0.0	\$	16.00	8		\$880
Maintenance		0.1	\$	16.00	8		\$1,760
	Total Operations an	d maintenance	labor	costs			\$59,577
Other Operations and Maintenance Costs							
	35% of operating la	hor				\$	20,852
•	2% of plant cost					\$	
	0.25% of plant cost					\$	
	0.50% of plant cost					\$	
	1% of plant cost					\$	72,647
Insurance	0.50% of plant cost					\$	36,324
Overhead Costs	40% of labor, super	vision,maint co	st			\$	23,831
Administrative Costs	1% of annual sales	(less tax credit	s)			\$	3,929
Distribution and Sales	0.5% of annual sale	es (less tax cred	lits)			\$	-
Total O&M Costs							\$416,939
perating Expenses:							
Utilities	1,757,995	2,349,741					
Raw Materials	593,315	796,588					
Processing Materials	291,248	267,948					
Operation & Maintenance	416,939	680,780					
Property Tax @ 0.50% Book Value	45,656	79,234					
Depreciation	608,749	1,056,454					
Debt retierment	1,254,118	1,418,471	_				

Savings With PureVision \$ 1,681,197 / yr =

Total Operating Expense (\$/yr)

based only on estimated enzyme production costs

\$4,968,020

6,649,217

25.3%

#### ASSUMPTIONS

ASSUME HONS		
	NREL (.45)	3442
Fraction of pre-treated liquor required	5.024%	3.768%
Fraction of wastewater treated	4.38%	3,28%
Fraction of steam required	1.74%	1.31%
Fraction of ammonia required	15.77%	15.54%
Fraction of CSL required	22.03%	17.57%
ammonia storage tank estemated cost	\$ 100,000	



# Comparison of On-Site Cellulase Production via Pure Vision Technology and NREL Reference Model, to Purchase of Commercially Available Enzyme

## CURRENT ASSUMPTION: BASED ON PUREVISION LABORATORY RESULTS OF COMPARISON

		NREL*	ŧ -			Pur	re Vision			Purc	chased Cellulase ***
		M FPI	U required/yr**		difference	Mi	FPU required/yr		difference	MF	PU required/yr
			1,446,984		(50,708)		1,497,692		56,431		1,554,123
perating Projection:											
gal of fuel grade ethanol produced		\$	25,434,849	\$	(311,275)	\$	25,746,124	\$	933,825	\$	26,679,948
Contract sale price per gallon		\$	1	\$	-	\$	1	\$	-	\$	1
Gross Annual Revenue		\$	27,978,334	\$	(342,402)	\$	28,320,736	\$	1,027,207	\$	29,347,943
Small Ethanol Producer Tax Credit											
@ \$ - per gallon		\$			•	\$				\$	<del>.</del>
Total projected ethanol sales and credit		\$	27,978,334	\$	(342,402)	\$	28,320,736	\$	1,027,207	\$	29,347,943
Gross Annual Co-Product Revenue		\$	328,822	\$	-	\$	328,822	\$	-	\$	328,822
Gross Sales and Credit		\$	28,307,156	\$	(342,402)	\$	28,649,558	\$	1,027,207	\$	29,676,765
Operating Expenses:					•						!
Utilities		<b>s</b>	4,792,171	\$	567,400	\$	4,224,771	\$	(1,803,557)	\$	2,421,214
Raw Materials		\$	12,843,241	\$	96,523		12,746,718		4,488,530,135		4,501,276,853
Processing Materials		\$	267,948		66,987		200,961		(200,961)		7,001,210,000
Operation & Maintenance		s	6,414,114		70,428		6,343,686		(505,618)		5,838,069
Property Tax @ 0.50% Book Value		\$	486,736		57,315		429,421		, , ,		400,888
Depreciation		\$	6,038,644		744,902	-	5,293,743		(340,048)		4,953,694
Total Operating Expense		\$	30,842,855	\$	1,603,554	\$	29,239,301	\$	4,485,651,417	\$	4,514,890,718
Net Operating Income		s	(2,535,699)		(1,945,956)				(4,484,624,210)		(4,485,213,953)
Hot Operating modified		*	(2,000,000)	Ψ	(1,040,000)	Ψ	(303,172)	\$ \$	4,404,024,210)	Ψ	(4,400,210,300)
Net Operating Cash Flow		\$	3,502,945	\$	(1,201,055)	\$	4,704,000	\$(	(4,484,964,258)	\$	(4,480,260,258)
enzyme cost (cost of production calculated in "\$per lb. calcs.") divided by lbs. per year flow rate from mass balance.	\$/Ib	\$	0.027			\$	0.020			\$	2.413
enzyme cost (cost of production calculated in "\$per lb. calcs.") divided by	·					•				*	
million FPU per year required.	\$/MFPU	\$	4.60			\$	3.32			\$	2,753.93
į į			Annual	Sav	vings Using Pure	eVis	ion On-Site Enz	zym	e Production	—	
					RENCE MODEL:		1,201,055				
1			OVER PUR	(CH/	ASED ENZYME:	\$	4,484,964,258				

^{* 45%} scale factor applied, SHCF

^{* *} MFPU = million FPU

^{* * *} Specialty Enzymes, Liquicell 2500, \$2.00/lb, S.G. 1.100, 32 FPU/ml. 14,7

#### PLAINS YORK MODEL WITH PURCHASED CELLULASE FOR COMPARISON OF ON-SITE ENZYME PRODUCTION VS. PURCHASED GAIN IN ETOH PRODUCTION POSSIBLE:

332 kg/hr

10/27/99

ENZYMATIC HYDROLYSIS - PRO FORMA

lying Assumptions & Input Variables

JRRENT SITUATION:

The Pro Forma models an Enzymatic Hydrolysis Ethanol plant using corn stover as the

**ETHANOL** 

The plant will convert corn stover to fuel grade ethanol utilizing enzymatic hydrolosis.

Corn stover feed rate of

71,977 kg/hr (str 101), produce estimated total output in

equivalent kilograms of fuel grade ETOH

9.483 kq/hr. = 79,659,865 kg / year (str 515)

gal./short ton=

76.8

3,176 gal/hr =

26,679,948 gal / year

gal./metric ton=

84.7

72%

Increase to current York yearly production:

The model assumes renewal of the ethanol excise tax credit of \$.54 per gallon to the blender and NOT the small producer tax credit of \$.10 per gallon through the year 2015 for a total ethanol value of

\$1.10 per gallon or

\$0.37 per kg and

\$ 29,347,943 per year TOTAL Ethanol sales

CARBON DIOXIDE

Currently, carbon dioxide from the High Plains York fermentations is sold to a CO₂ compression company.

Diverting the CO₂ (stm 550) from the stover plant into this stream for sale as opposed to the atmosphere provides

110,749 kg/hr =

930,294 ton / year

with a value of \$

4.13 per metric ton

WITH THIS PROFORMA NO CO2 IS SOLD. CO2 Value/year = \$0

LIGNIN

A Lignin co-product is produced and sold as combustion fuel material. A total amount of lignin in the stream (stm 601B) is

63,778 kg/hr = 535,734 metric ton / year is produced from the process.

The water in the lignin stream must be vaporized at a net BTU cost for the stream (stm 601B). Water vaporized is

369,337 metric ton/year is vaporized at 1,100 BTU/lb loss =

(107) MM BTU/hr

43,969 kg/hr =

The remaining

19,809 kg/hr of stream 601B has 24,251 BTU/kg value =

480 MM BTU/hr

Total heating value from stream 601A is

374 MM BTU/hr

Gross Lignin Value/year = \$7,848,926 Transport Cost = \$7,848,926

Net Lignin Value = \$0

**METHANE** 

The digester produces 85% methane @

353 kg/hr (stm 615)

44,332 BTU/kg CH4

Total heating value from Methane is

16 MM BTU/hr

methane is used in the DDG dryers and based on BTU value of

\$2.50 MM BTU

METHANE Value/year = \$328,822

DIGESTER SLUDGE

The digester produces (stm 623)

0 kg/hr of sludge as fuel =

2.254 BTU/lb

based on 9,845 btu/lb biomass and 70% water in the sludge.

Total heating value from sludge is

4,969 BTU/kg

0.00 MM BTU/hr SLUDGE Value/year = \$0

Sale of methane and lignin, based on BTU value is

\$328,822 per year

Total projected facility sales would be

\$29,676,765 per year

Pfpve

# APITAL INVESTMENT ASSUMPTIONS

	Net Capital Investment	\$403,464,190	
FEDERAL & STATE GRANTS	10%	(\$44,829,354)	
	Total Plant Cost	\$448,293,544	
Working Capital per estimate		<b>\$375,592,910</b> 1	mos Raw matls. + O&M
Start-up, Permits, Fees	3.0%	\$1,574,743	
Contingency	10.0%	\$5,249,143	
Home Office Constr. Fee	12.0%	\$6,298,972	
Field Expense	8.0%	\$4,199,315	
Process Development	2.0%	\$1,049,829	
INDIRECTS Prorateable	3.5%	\$1,837,200	
Fixed Capital		\$52,491,432	
Area 900		2,236,491	
Area 800		3,684,612	
Area 700		234,910	
Area 600		9,824,251	
Area 500		7,515,486	
Area 400		651,440	
Area 307		3,714,334	
Area 300		4,028,307	
Area 200		14,955,166	
Area 100		6,146,434	
Civil Structural		(500,000)	
Total capital investment			

PERATING COST ASSUMPTIONS

8,400 hr/yr

Utilities (Rates based on	26,679,948 gal/yr produced)				
	<u>Amount/hr</u>	<u>Units</u>	\$/unit	Cost /hr.	Total Cost /yr
*Electricity	6,759	Kw-hr	\$0.035	\$237	\$1,987,079
Well water	79,972	kg	\$0.000	\$0	\$0
*Wastewater	<b>39</b> ,119	kg	\$0.00026	\$10	\$86.808
*Gypsum waste disposal	1,137	kg	\$0.0364	\$41	\$347,327
		mTon	\$1.103	\$0	\$0
Total Utilities * Quoted by High Plains				\$288	\$2,421,214

Com Stever DRY (stm 101 less water)	Raw Material Costs						
Sulfuric Acid (stm 710)		Amount/hr	<u>Units</u>		<u>\$/unit</u>	Cost /hr.	Total Cost /yr
Calcium Hydroxide (Lime stm 227)   337 kg   \$0.283   \$98.70   \$829.039     Ammonia (stm 717)   387 kg   \$0.162   \$52.77   \$527.281     Corn Steep Liduor (stm 735)   708 kg   \$0.051   \$361.0   \$303.280     Nutrients (stm 415)   0 kg   \$0.291   \$0.00     Survinsaed Cellulase   2111.23   lbs   \$2.200   \$422.2467   \$3,346.872,248     transport cost   750 miles   \$3.000   \$222.60   cost   \$733.071.990     Natural Gasoline (stm 701)   391 kg   \$0.155   \$60.36   \$506.988     Holling Stock Casoline   79 kg   \$0.155   \$12.32   \$103.470     Hormacials   77 kg   \$0.000   \$0.00   \$0.00   \$0.00     Hormacials   77 kg   \$0.000   \$0.00   \$0.00   \$0.00     Hormacials   77 kg   \$0.000   \$0.00   \$0.00   \$0.00     Hormacials   77 kg   \$0.000   \$476.07   \$3.998,989     Total Raw Materials   78 kg   \$0.250   \$476.07   \$3.998,989     Total Raw Materials   78 kg   \$0.304   \$0.000   \$476.07   \$3.998,989     Total Processing Material Costs   Amounthr   Units   Sunit   Cost /hr   Total Cost /hr     Antiform (Corn Oil)   0 kg   \$0.304   \$0.00   \$0.00     Antiform (Corn Oil)   0 kg   \$0.304   \$0.00   \$0.00     Total Processing Materials   \$0.000   \$0.00   \$0.00     Antiform (Corn Oil)   0 kg   \$0.304   \$0.00   \$0.00     Antiform (Corn Oil)   0 kg   \$0.00   \$0.00   \$0.00     Antiform (Corn Oil)   0 kg   \$0.00   \$0.00   \$0.00     Antiform (Corn Oil)   0 kg   \$0.00   \$0.00   \$0.00	Corn Stover DRY (stm 101 less water)	37,500	kg		\$0.680	\$25,499.90	\$214,199,143
Ammonal (stm 717)	*Sulfuric Acid (stm 710)	860	kg		\$0.100	\$86.26	\$724,592
Consider   Liquor (sitm 735)   708	*Calcium Hydroxide (Lime stm 227)	337	kg		\$0.293	\$98.70	\$829,039
Nutrients (stim 415)	*Ammonia (stm 717)	387	kg		\$0.162	\$62.77	\$527,281
Purchased Cellulase	Corn Steep Liquor (stm 735)	708	kg		\$0.051	\$36.10	\$303,280
transport cost         750         miles         \$3,000         \$2250 /load         \$733,071,990           Natural Gasoline (stm 701)         391         kg         \$0.155         \$60,86         \$506,988           *Rolling Stock Gasoline         79         kg         \$0.165         \$12.32         \$103,470           *WWT Chemicals         5         kg         \$0.000         \$0.000         \$0.00         \$0.00           **GWC Chemicals         73,8         kg         \$0.226         \$16.65         \$139,833           **Boller Fuel (stm 813)         190         Mbtu         \$2.500         \$476.07         \$3,998,989           **Total Raw Materials         ************************************	Nutrients (stm 415)	0	kg		\$0.291	\$0.00	\$0
*Natural Gasoline (stm 701) 331 kg \$0.155 \$0.036 \$506,888 \$6018 \$7018 \$1018 \$102.22 \$103.477 \$1018 \$1018 \$102.22 \$103.477 \$1018 \$102.22 \$103.477 \$1018 \$102.22 \$103.477 \$1018 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22 \$102.22	Purchased Cellulase	211,123	lbs		\$2.000	\$422,246.70	\$3,546,872,248
*Rolling Stock Gasoline 79 kg \$0,165 \$12,32 \$103,470 *WWT Chemicals 5 kg \$0,000 \$0,000 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0 \$0	transport cost	750	miles		\$3.000	\$2250 /load	\$733,071,990
*WIT Chemicals	*Natural Gasoline (stm 701)	391	kg		\$0.155	\$60.36	\$506,988
**Total Processing Materials	*Rolling Stock Gasoline	79	kg		\$0.155	\$12.32	\$103,470
*BFW Chemicals	*WWT Chemicals	5	kg		\$0.000	\$0.00	\$0
**Boiler Fuel (stm 813)** 190 Mbtu \$2.500 \$476.07 \$3,998,989  Total Raw Materials \$448,596 \$44,501,276,853  **Total Raw Material Costs	*CW Chemicals	17	kg		\$0.000	\$0.00	\$0
Total Raw Materials         \$448,596         \$4,501,276,853           * Quoted by High Plains           Processing Material Costs           Amount/in         Units         \$tunit         Cost /hr.         Total Cost /yr.           *Antifoam (Corn Oil)         0         kg         \$0.304         \$0         \$0           Total Processing Materials         \$0         \$0         \$0         \$0         \$0           *Quoted by High Plains         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0         \$0	*BFW Chemicals	73.8	kg		\$0.226	\$16.65	\$139,833
* Quoted by High Plains           Processing Material Costs         Amount/hr         Units         \$/unit         Cost //hr.         Total Cost /yr.           *Antifoam (Corn Oil)         0         kg         \$0.304         \$0         \$0           Total Processing Materials         \$0         \$0         \$0           * Quoted by High Plains         \$0         \$1         \$0           Operations and Maintenance Costs - DRY HANDLING (area 100)         each/day         wage         hr/day each         Total Cost /yr.           *Supervisors         0.5         \$ 20.00         12         \$43,800           *Operatiors         0.5         \$ 20.00         12         \$43,800           *Operatiors         8.0         \$ 16.00         12         \$43,800           *Operatiors         8.0         \$ 16.00         12         \$560,640           *Maintenance         1.0         \$ 20.00         12         \$87,600           *Operations and Maintenance Costs - HYDROLYSIS/FERMENTATION (area 200, 300, 400, 500, 600)         ***         \$87,600           *Operations         8.0         \$ 16.00         8         \$373,760           *Laborers         4.0         \$ 16.00         8         \$140,160 <t< td=""><td>*Boiler Fuel (stm 813)</td><td>190</td><td>Mbtu</td><td></td><td>\$2.500</td><td>\$476.07</td><td>\$3,998,989</td></t<>	*Boiler Fuel (stm 813)	190	Mbtu		\$2.500	\$476.07	\$3,998,989
Processing Material Costs	Total Raw Materials					\$448,596	\$4,501,276,853
Amount/n	* Quoted by High Plains						
*Antifoam (Corn Oil) 0 kg \$0,304 \$0 \$0  Total Processing Materials \$0 \$0  *Quoted by High Plains  *Operations and Maintenance Costs - DRY HANDLING (area 100) each/day wage hr/day each 12 \$43,800  *Operations and Maintenance Costs - DRY HANDLING (area 100) 12 \$43,800  *Operators 2.0 \$16.00 12 \$43,800  *Uniform 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 12 \$43,800  *Maintenance 2.0 \$16.00 8 \$43,760  *Maintenance 3.0 \$16.00 8 \$416,880  *Maintenance 3.0 \$16.00 8 \$4140,160  *Maintenance 2.0 \$16.00 8 \$4140,160  *Maintenance 2.0 \$16.00 8 \$4140,160  *Maintenance 3.0 \$140,160  *Maintenance 3.0 \$16.00 8 \$4140,160  *Maintenance 3.0 \$140,160  *Maintenance 3.0	Processing Material Costs						
Total Processing Materials   Quoted by High Plains   Squared by High		<u>Amount/hr</u>	<u>Units</u>		<u>\$/unit</u>	<u>Cost /hr.</u>	Total Cost /yr
*Quoted by High Plains    Operations and Maintenance Costs - DRY HANDLING (area 100)   each/day   wage   hr/day each   Total Cost /yr.	*Antifoam (Corn Oil)	0	kg		\$0.304	\$0	\$0
*Supervisors	·					\$0	\$0
*Operators 2.0 \$ 16.00 12 \$140,160 *Laborers 8.0 \$ 16.00 12 \$560,640 *Maintenance 2.0 \$ 16.00 12 \$560,640 *Maintenance 2.0 \$ 16.00 12 \$140,160 *Maintenance 2.0 \$ 16.00 12 \$140,160 *Maintenance 2.0 \$ 16.00 12 \$140,160 *Maintenance 2.0 \$ 16.00 12 \$140,160 *Maintenance 2.0 \$ 16.00 12 \$87,600 *Operators 8.0 \$ 16.00 8 \$373,760 *Laborers 4.0 \$ 16.00 8 \$186,880 *Technicians (Includes Lab.) 3.0 \$ 16.00 8 \$140,160 *Maintenance 2.0 \$ 16.00 8 \$140,160 *Maintenance 2.0 \$ 16.00 8 \$140,160 *Maintenance 3.0 \$ 16.00 8 \$140,160 *Maintenance 2.0 \$ 16.00 8 \$140,160 *Maintenance 3.0 \$16.00 8 \$140,160 *Maintenance 3.0 \$140,160 *Maintenance 3.0 \$16.00 8 \$140,160 *Maintenance 3.0 \$140,160 *Maintenance 3.0 \$16.00 8 \$140,160 *Maintenance 3.0 \$16.00 8 \$140,160 *Maintenance 3.0 \$140,160 *Maintenance 3.0 \$140,160 *Mainten	Operations and Maintenance Costs - DRY HAI	NDLING (area 100)	each/day		wage	hr/day each	Total Cost /yr.
**Laborers	*Supervisors		0.5	\$	20.00	12	
*Maintenance       2.0       \$ 16.00       12       \$140,160         Operations and Maintenance Costs - HYDROLYSIS/FERMENTATION (area 200, 300, 400, 500, 600)       **Supervisors       1.0       \$ 20.00       12       \$87,600         *Operators       8.0       \$ 16.00       8       \$373,760         *Laborers       4.0       \$ 16.00       8       \$186,880         *Technicians (Includes Lab.)       3.0       \$ 16.00       8       \$140,160         *Maintenance       3.0       \$ 16.00       8       \$140,160         *Supervisors       0.5       \$ 20.00       12       \$21,900         *Operators       3.0       \$ 16.00       8       \$70,080         *Laborers       1.0       \$ 16.00       8       \$23,360         *Technicians       1.0       \$ 16.00       8       \$23,360         *Technicians       1.0       \$ 16.00       8       \$23,360         *Maintenance       \$20.0       \$16.00       8       \$23,360         *Maintenance       \$20.0       \$16.00       8       \$23,360         *Maintenance       \$20.0       \$20.0       \$20.0       \$20.0       \$20.0       \$20.0       \$20.0       \$20.0       \$20.0 <th< td=""><td>*Operators</td><td></td><td>2.0</td><td>\$</td><td>16.00</td><td>12</td><td>\$140,160</td></th<>	*Operators		2.0	\$	16.00	12	\$140,160
Operations and Maintenance Costs - HYDROLYSIS/FERMENTATION (area 200, 300, 400, 500, 600)           *Supervisors         1.0         \$ 20.00         12         \$87,600           *Operators         8.0         \$ 16.00         8         \$373,760           *Laborers         4.0         \$ 16.00         8         \$186,880           *Technicians (Includes Lab.)         3.0         \$ 16.00         8         \$140,160           *Maintenance         3.0         \$ 16.00         8         \$140,160           Operations and Maintenance Costs - Utilities (area 700, 800, 900)         **         \$20.00         12         \$21,900           *Operators         3.0         \$ 16.00         8         \$70,080           *Coperators         3.0         \$ 16.00         8         \$23,360           *Laborers         1.0         \$ 16.00         8         \$23,360           *Technicians         1.0         \$ 16.00         8         \$23,360           *Maintenance         2.0         \$ 16.00         8         \$23,360           *Maintenance         2.0         \$ 16.00         8         \$23,360	*Laborers		8.0	\$	16.00	12	\$560,640
*Supervisors 1.0 \$ 20.00 12 \$87,600  *Operators 8.0 \$ 16.00 8 \$373,760  *Laborers 4.0 \$ 16.00 8 \$186,880  *Technicians (Includes Lab.) 3.0 \$ 16.00 8 \$140,160  *Maintenance 3.0 \$ 16.00 8 \$140,160  *Maintenance Costs - Utilities (area 700, 800, 900)  *Supervisors 0.5 \$ 20.00 12 \$21,900  *Operators 3.0 \$ 16.00 8 \$770,080  *Laborers 1.0 \$ 16.00 8 \$23,360  *Technicians 1.0 \$ 16.00 8 \$23,360  *Technicians 1.0 \$ 16.00 8 \$23,360  *Maintenance 2.0 \$ 16.00 8 \$23,360  *Maintenance 2.0 \$ 16.00 8 \$23,360  *Maintenance 2.0 \$ 16.00 8 \$246,720	*Maintenance		2.0	\$	16.00	12	\$140,160
*Operators	Operations and Maintenance Costs - HYDROL	YSIS/FERMENTATION	ON (area 200	, 300,	400, 500, 6	00)	
*Laborers	*Supervisors			\$	20.00	12	\$87,600
*Technicians (Includes Lab.)  *Maintenance  3.0 \$ 16.00 8 \$ \$140,160  *Maintenance  Operations and Maintenance Costs - Utilities (area 700, 800, 900)  *Supervisors  Operators  3.0 \$ 20.00 12 \$21,900  *Operators  3.0 \$ 16.00 8 \$70,080  *Laborers  1.0 \$ 16.00 8 \$23,360  *Technicians  1.0 \$ 16.00 8 \$23,360  *Maintenance  2.0 \$ 16.00 8 \$46,720  * Quoted by High Plains  Standard HPY shifts are 12 hours.	*Operators		8.0	\$	16.00	. 8	\$373,760
*Maintenance 3.0 \$ 16.00 8 \$140,160    Operations and Maintenance Costs - Utilities (area 700, 800, 900)	*Laborers		4.0		16.00	8	\$186,880
Operations and Maintenance Costs - Utilities (area 700, 800, 900)         *Supervisors       0.5       \$ 20.00       12       \$21,900         *Operators       3.0       \$ 16.00       8       \$70,080         *Laborers       1.0       \$ 16.00       8       \$23,360         *Technicians       1.0       \$ 16.00       8       \$23,360         *Maintenance       2.0       \$ 16.00       8       \$46,720	,						* *
*Supervisors 0.5 \$ 20.00 12 \$21,900 *Operators 3.0 \$ 16.00 8 \$70,080 *Laborers 1.0 \$ 16.00 8 \$23,360 *Technicians 1.0 \$ 16.00 8 \$23,360 *Maintenance 2.0 \$ 16.00 8 \$46,720 *Quoted by High Plains**  Standard HPY shifts are 12 hours.	*Maintenance		3.0	\$	16.00	8	\$140,160
*Operators 3.0 \$ 16.00 8 \$70,080 *Laborers 1.0 \$ 16.00 8 \$23,360 *Technicians 1.0 \$ 16.00 8 \$23,360 *Maintenance 2.0 \$ 16.00 8 \$46,720 *Quoted by High Plains Standard HPY shifts are 12 hours.		area 700, 800, 900)					
*Laborers 1.0 \$ 16.00 8 \$23,360 *Technicians 1.0 \$ 16.00 8 \$23,360 *Maintenance 2.0 \$ 16.00 8 \$46,720  * Quoted by High Plains Standard HPY shifts are 12 hours.	•				20.00	12	\$21,900
*Technicians 1.0 \$ 16.00 8 \$23,360 *Maintenance 2.0 \$ 16.00 8 \$46,720 * *Quoted by High Plains Standard HPY shifts are 12 hours.	•						\$70,080
*Maintenance 2.0 \$ 16.00 8 \$46,720  * Quoted by High Plains Standard HPY shifts are 12 hours.			1.0	\$	16.00	8	\$23,360
* Quoted by High Plains Standard HPY shifts are 12 hours.						8	\$23,360
	*Maintenance		2.0	\$	16.00	8	\$46,720
Total Operations and maintenance labor costs \$1,998,740	* Quoted by High Plains Standard HP	Y shifts are 12 hours.					
		Total Operations ar	nd maintenan	ce lat	oor costs		\$1,998,740

\$

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3.0%

699,559

1,049,829

131,229

262,457

524,914

262,457

799,496

109,388

\$5,838,069

Other Operations and Maintenance Costs				
Payroll Overhead	35% of operating labor			5
Maintenance Costs	2% of plant cost			5
Operating Supplies	0.25% of plant cost			(
Environmental	0.50% of plant cost			5
Local Taxes	1% of plant cost			5
Insurance	0.50% of plant cost			5
Overhead Costs	40% of labor, supervisi			5
Administrative Costs	1% of annual sales (les		,	
Distribution and Sales	0.5% of annual sales (I	ess tax cre	edits)	9
Total O&M Costs				
THER MODEL ASSUMPTIONS				
rerage prevailing market price of fuel grade ETOI	H:		<b>\$0.37</b> per kg	
sumes renewal of the ethanol excise tax credit of	of \$.54 per gallon		\$ 1.10 per gallon	
d the small producer tax credit of \$.10 per gallon	through the year 2007		An important properties the significant conference and significant control in the conference of the co	
/alue of CO ₂ produced			\$ 4.13 per metric ton	
Price for Electricity			\$ 0.035 per KWhr	
Gas price per million BTU			\$ 2(500) per MM BTU	
sas price per million DTO			\$ 2.000 per MINI BTO	
			Dry matter	
orn Stover feedstock cost- dry basis/short ton	\$ 14,45		per kg	
		\$15.93	per metric ton	
ant on-stream factor			0.959	
ant operating hours per year			8,400	
epreciable Life of Capital Equipment			15 years	
verage annual commodity escalation rate:			3.0%	
Ì			Assessment and Various and in Land in James and S	

Pfpve

verage annual cost escalation rate:

There are no land acquisiton costs included.

There are no off site costs included (e.g. public road

There exist adequate roads and rail roads to allow

The costs for air and water permits are not included. Soils are adequate for conventional foundation designs.

improvements, extensions of power, water, telephone services) There is a source of qualified construction personnel within daily

* Quoted by High Plains

driving distance of the site

equipment delivery.

#### CALCULATIONS FOR REQUIRED AMOUNT OF PURCHASED CELLULASE LIQUICELL 2500

# ASED ON PUREVISION LABORATORY RESULTS OF COMPARISON

High Grade Waste Paper Substrate

Soluble Charbohydrate % degraded in 18 hrs.

Liquicell 2500 13% PureVision Cellulase 82%

82% 13,057,632 ml/hr required for stover

87,059,020 ml/hr required for stover

effectiveness multiple 6.43

1110		
125	FPU/g protein	Liquiceli 2500
731,295,772	liters/yr	Specialty
1.1000	S.G.	Enzymes
804,425,349	kg/yr	Inc.
193,062,084	gal/yr	
1,773,436,124	#/yr	
325,810	loads/yr	

cellulase storage tank

22,984 gal/hr

750,000 gal/vessel

33 vessel res. time (hr)

cellulase transfer pump

383 gpm

## ASED ON PRODUCT SPECIFICATIONS PROVIDED BY SPECIALTY ENZYMES INC.

32	FPU/ml	Liquicell 2500
48,566,337	liters/yr	Specialty
1.1000	S.G.	Enzymes
53,422,971	kg/yr	Inc.
12,821,513	gal/yr	
117,776,282	#/yr	
21,637	loads/yr	

cellulase storage tank

14,021 gal/hr

750,000 gal/vessel

53 vessel res. time (hr)

cellulase transfer pump

234 gpm

## ransport Calculations

10,000 lbs/axel

9.19 cellulase lb/gal

5 axels/truck

5,443 gal/truck

50,000 lbs/truck

0.413 transport cost/lb

sumai	eu E	quipn	ent Costs for Reference	Model	caled Dov	vn 45%	with	Manges to Eq	uipa aut	matically update thes	e cells with th	e exception of the	se noted	in red.
l	i	ŀ			Scaling	New		Original		Total Original				
Equip	No.	No.		Scaling	Stream Flow	Stream	Size	Equip Cost	Base	Equip Cost (Reg'd	Scaling	Scaled Cost in	Install	
No.	Req'd	Spare	Equip Name	Stream	(Kg/hr)	Flow	Ratio	(per unit)	Year	& Spare)	Exponent	Base Year	Factor	Installed

Ratio

170 1.11 170 1.11

(per unit) Year

\$15,000 1999 \$159,830 1999

& Spare)

\$15,000

(Kg/hr)

154

AREA0100

Equip Name

0 Bale conveyor 0 Radial Stacker Conveyor

G-101	1 1	1 0	Bale conveyor	AREA0100	154	170	1.11	\$15,000	1999	\$15,000	0.6	\$15,927	1.5	\$24,551	\$ 15,927	wire mesh conveyor 60" wide 20' long	WC101	11.93
C-102	1	0	Radial Stacker Conveyor	AREA0100	154	170	1.11	\$159,830	1999	\$159,830	0.6	\$169,708	1,5	\$261,604	\$ 169,708		WC102	44.74
1	ł	1				1										84" x 35' rubber belt cleated infeed conveyor, 10 HP, TEFC drive motor with		
C-103	1	] 0	Breaker Infeed Belt	AREA0100	154	170	1.11	\$49,500	1999	\$49,500	0.6	\$52,559	1.5	\$81,020	\$ 52,559	quard	WC103	5.97
C-104	1	0	1st Shredder Conveyor	AREA0100	154	170	1.11	\$25,650	1999	\$25,650	0.6	\$27,235	1.5	\$41,983	\$ 27,235	60" wide x 25' long, 10 HP, TEFC drive with guard	WC104	5.97
C-105	1	. 0	1st Infeed Belt	AREA0100	154	170	1.11	\$38,500	1999	\$38,500	0.6	\$40,879	1.5	\$63,015		60" wide x 30' long, 10 HP, TEFC drive with guard	WC105	11.93
C-106	1	0	2nd Shredder Conveyor	AREA0100	154	170	1.11	\$29,500	1999	\$29,500	0.6	\$31,323	1.5	\$48,285	\$ 31,323		WC106	4.47
C-107	1	1 0	2nd Infeed Belt	AREA0100	154	170	1.11	\$27,500	1999	\$27,500	0.6	\$29,200	1.5	\$45,011	\$ 29,200	48" wide x 30' long, 5 HP, TEFC drive with guard	WC107	2.98
C-108	1	0	3rd Shredder Conveyor	AREA0100	154	170	1.11	\$29,500	1999	\$29,500	0.6	\$31,323	1.5		\$ 31,323		WC108	5.97
C-109	1	0	Feed Screw Conveyor	AREA0100	225,140	562,850	2.50	\$31,700	1997	\$31,700	0.6	\$54.932	1.5	\$86,351			WC109	53.75
M-101	2	0	Truck Scale	AREA0100	96	72	0.75	\$10,000	1999	\$20,000	0.6	\$16,829	1.5				-110103	55,75
M-102	1	0	Receiving Pad	AREA0100	250,000	250,000	1.00	\$2,083,500		\$2,083,500	0.6	\$2,083,500	1.0		\$ 2.083.500	250,000 ft2 concrete pad, 9" thick with drainage	-1	
M-103	6	1	Front End Loader	AREA0100	159,948	159,948	1.00	\$156,000	1998	\$1,092,000	0.6	\$1,092,000	1.2			run on gasoline		
M-104	3	0	Bale Breaker	AREA0100	154	170	1.11	\$250,000	1999	\$750,000	0.6	\$796,352	1.2	\$955,622	\$ 796,352	30 HP each		53.69
M-105	1	0	Primary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.2	\$135,444			WM105	149.14
M-106	1	0	Secondary Stover Shredder	AREA0100	154	170	1.11	\$106,300	1999	\$106,300	0.6	\$112,870	1.5	\$169,304	\$ 112.870			
M-107	1	0	Shred Bunker	AREA0100	600,000	600,000	1.00	\$700,000	1999	\$700,000	0.6	\$700,000	1.0	\$700,000	\$ 700,000		WM106	149.14
M-108	1	1 0	Storm Runoff Pond	AREA0100	1,747,767	1,747,767	1.00	\$51,198	1998	\$51,198	0.6	\$51,198	1.0	\$51,198		200x100x30ft bunker with three walls, 3 days shred storage 200 x 150 x 8 ft, 240,000ft3	_	
		1	Total I real of the	T ARCAGIGO	1,141,101	1,747,707	1.00	1 331,135	1930	weighted averages:	0.6	\$51,196		\$51,198	\$ 51,808	200 x 150 x 8 n, 240,000n3		
A100											0.6		1,1				1	499.68
,,,,,									Subtotal			\$5,418,705		\$6,146,434	\$5,433,414			
						2	ocotpd:	x .45 (current ye	ear cost	with area weighted-av			1.3	\$3,181,636	(\$2,964,798)	is installed cost savings		
A-201		0	In-line Sulfuric Acid Mixer	I							Base Year =	\$1,999					_	
A-202		1 0		STRM0214	55,308	23,725	0.43	\$1,900	1997	\$1,900	0.48	\$1,266	1.2			Static Mixer, 110 gpm total flow		
A-209	+ +-	1 0	In-line NH3 Mixer	STRM0244	53,630	18,317	0.34	\$1,500	1997	\$1,500	0.48	\$896	1.2	\$1,122		Static Mixer, 82 gpm total flow		
	1		Overliming Tank Agitator	STRM0228	167,050	102,608	0.61	\$19,800	1997	\$19,800	0.51	\$15,442	1.2	\$19,345		Top Mounted, 1800 rpm, 15 hp	WT209	8,39
A-224	<u>'</u>	0	Reacidification Tank Agitator	STRM0239	167,280	102,752	0.61	\$65,200	1997	\$65,200	0.51	\$50,851	1.2	\$63,702		Top-Mounted, 1800 rpm, 54 hp	WT224	25.17
A-232	1	0	Reslurrying Tank Agitator	STRM0250	358,810	167,795	0.47	\$36,000	1997	\$36,000	0.51	\$24,432	1.2	\$30,606		Top-Mounted, 1800 rpm, 25 hp	WT232	13.98
A-235	1	0	In-line Acidification Mixer	STRM0236	164,570	101,104	0.61	\$2,600	1997	\$2,600	0.48	\$2,058	1.2	\$2,578	\$2,099	Static-Mixer, 440 gpm lotal flow	7	
C-201	11_	0	Hydrolyzate Screw Conveyor	STRM0220	225,140	101,493	0.45	\$59,400	1997	\$59,400	0.78	\$31,908	1.5	\$50,158	\$32,539	18" dia. 33' long, 3420 cfh max flow, 23 hp	WC201	13.72
C-202	1	0	Wash Solids Screw Conveyor	STRM0225	196,720	165,453	0.84	\$23,700	1997	\$23,700	1	\$19,933	1.5	\$31,334		18" dia. 16' long, 3420 cfh max flow	WC202	16.70
C-225	1	0	Lime Solids Feeder			0		\$3,900	1997	\$3,900	1	\$3,900	1.5	\$6,131		6" dia., 63 cfh, 3150 lb/hr max flow	WC225	0.15
H-200	1	0	Hydrolyzate Cooler	AREA0200	1,988	895	0.45	\$45,000	1997	\$45,000	0.51	\$29,947	2.2	\$66,543	\$30,539	Fixed Tube Sheet, 900 st, 20" dia. X 20' long	-	
H-201	1	1 1	Beer Column Feed Economizer	AREA0201	5,641	5,641	1.00	\$139,350	1999	\$278,700	0.68	\$278,700	2.2	\$607,278		TEMA type AES shell and tube 5641 sl, 42" dra x 20' long	1	
M-202	1	0	Prehydrolysis Reactor	STRM0217	270,034	121,514	0.45	\$12,461,841	1998	\$12,461,841	0.78	\$6,684,746	1.5	\$10,146,612		Vertical Screw, 10 min residence time	VVM 105	353.16
P-201	1	1	Sulfuric Acid Pump	STRM0710	1,647	414	0.25	\$4,800	1997	\$9,600	0.79	\$3,228	2.8	\$9,190		2 gpm, 245 ft. head	WP201	0.40
P-209	1	1	Overtimed Hydrolyzate Pump	STRM0228	167,050	102,608	0.61	\$10.700	1997	\$21,400	0.79	\$14,561	2.8	\$41,458		448 gpm, 150 ft. head	WP209	18.01
P-222	1	1	Filtered Hydrolyzate Pump	STRM0230	162.090	101.614	0,63	\$10,800	1997	\$21,600	0.79	\$14,936	2.8	\$42,526		448 gpm, 150 ft head	WP222	17.83
P-223	1	0	Lime Unloading Blower	STRM0227	547	337	0.62	\$47,600	1998	\$47,600	0.5	\$37,340	1.4	\$52,898	\$37.785	3341 cfm, 6 psi, 10,024 lb/hr	WP223	4.10
P-224	1	1	Hydrolysis Feed Pump	\$TRM0250	160,000	167,795	1.05	\$64,934	1999	\$129,868	0.6	\$133,628	1.2	\$160,354		740 gpm, 240 ft head	WP224	119.31
P-225	1	1	ISEP Elution Pump	STRM0243	52,731	18.005	0.34	\$7,900	1997	\$15,800	0.79	\$6,761	2.8	\$19,249		104 gpm, 150 ft head	WP225	3.92
P-226	1	1	ISEP Reload Pump	STRM0246	164,080	100,802	0.61	\$8,700	1997	\$17,400	0.79	\$11,841	2.8	\$33,714		445 gpm, 150 ft head	WP225	
P-227	1	1	ISEP Hydrolyzate Feed Pump	STRM0221	160.290	98.157	0.61	\$10,700	1997	\$21,400	0.79	\$14,526	2.8	\$41,359		432 gpm, 150 ft head		17.92
P-239	1	1	Reacidified Liquor Pump	STRM0239	167,280	102.752	0.61	\$10,800	1997	\$21,600	0.79						WP227	16.81
S-202	3	0	Pre-IX Belt Filter Press	SOLD0220	57,000	57,000	1.00	\$200,000	1998	\$21,800		\$14,698	2.8	\$41,847	\$14,988	450 gpm, 100 ft head	WP239	12.09
S-221	1	0	ISEP	STRM0240	210.005	98,157	0.47	\$2,058,000	1998	\$2,058,000	0.39	\$600,000	1.4	\$850,010		Use 3 units for 45% of the flow as recommended by the vendor	W\$202	19.69
S-222	- <del>-</del> -	+ <del>,</del>	Hydroclone & Rolary Drum Filter	STRM0229							0.33	\$1,601,194	1.2	\$1,959,422		10 chambers (39" dia. X. 84" high), 4" dia. Valve - Weak Base Resin	WS221	2.98
S-227		- 0			5,195	1,137	0.22	\$165,000	1998	\$165,000	0.39	\$91,224	1.4	\$129,235		Hydrocyclone and Vacuum Filter for 453 gpm		11.93
T-201	<del>-</del>	0	LimeDust Vent Baghouse	STRM0227	548	337	0.61	\$32,200	1997	\$32,200	1	\$19,778	1.5	\$30,254		3750 cfm, 625 sf, 6 cfm/sf	_	
	1	0	Sulfuric Acid Storage	STRM0710	1,647	860	0.52	\$5,760	1996	\$5,760	0.71	\$3,633	1.7	\$6,283		2000 gal., 24 hr. residence time, 90% wv, 5,5ft diam. X 11ft	_]	
T-203			Blowdown Tank	STRM0217	270,300	121,514	0.45	\$64,100	1997	\$64,100	0.93	\$30,475	1.7	\$52,061		7000 gal., 11' dia x 30' high, 10 min. res. time, 75% wv, 15 psig	]	
T-209	1	0	Overliming Tank	STRM0228	167,050	102,608	0.61	\$71,000	1997	\$71,000	0.71	\$50,232	1.6	\$90,186		29850 gal., 16' dia. X 32' high, 1 hr. res. time, 90% wv, 15 psig	7	
T-220	!	0	Lime Storage Bin	STRM0227	548	548	1.00	\$69,200	1997	\$69,200	0.46	\$69,200	1.8	\$124,243		4455 cf, 14' dia x 25' high, 1.5x rail car vol., almospheric, 15 day storage m	ax	
T-224		0	Reacidification Tank	STRM0239	102,752	102,752	1.00	\$111,889	1999	\$111,889	0.51	\$111,889	1.8	\$196,992	\$111,889	120,000 gal., 28' dia x 28' high, 4 hr. res. time, 90% wv, atmospheric	٦	
T-232	1	0	Slurrying Tank	STRM0250	358,810	167,795	0.47	\$44,800	1997	\$44,800	0.71	\$26,117	1.8	\$46,890	\$26,633	11300 gal., 13' dia. X 25' high, 15 min. res. time, 90% wv	7	
0	0	1 0	0	0	0	0	0.00	\$0	1999	\$0	0	\$0		\$0	\$0	0	7	
										weighted averages:	0,696961		1.5				٦ .	676.27
A200								s	ubtotal	\$16,527,758		\$9,999,337	_	\$14,955,166	\$10,128,493		1	
						20	000tpd x	.45 (current ve	ar cost v	with area weighted-ave	erage scale ex		1.5	\$15,025,380		is installed cost savings		
						-		()				particular popular (1)		-10,0E0,000	wru,210	to instance door advings		

Base Year

\$15,927

Exponent

0.6

1.5

Scaled

Uninstalled

Description

15,927 wire mesh conveyor 60" wide 20' long

Factor Installed Cost Cost in 1999\$

\$24,551 \$

C-101 C-102

3442 WORK

11.93

A-300	8	0	Fermentor Agitators	GALLONS	962,651	750,000	0.78	\$19,676	1996	\$157,408	0.51	\$138,592	1.2	\$175,799	\$143,110 Side Mounted, 2 per vessel, 60 hp each, 0.15 hp/1000 gal	lwr300	201.34
A-301	1	0	Seed Hold Tank Agitator	STRM0304	41,777	17,529	0.42	\$12,551	1996	\$12,551	0.51	\$8,060			\$8,322 Top Mounted, 1800 rpm, 10 hp, 0.1 hp/1000 gal	WT301	5.59
A-304	2	0	4th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$11,700	1997	\$23,400	0.51	\$15,026	1.2	\$18,824		WT304	3.36
A-305	2	0	5th Seed Vessel Agitator	STRM0304	41,777	17,529	0.42	\$10,340	1996	\$20,680	0.51	\$13,280	1.2	\$16,845		WT305	10.07
A-306	1	0	Beer Well Agitator	STRM0502	381,700	173,737	0.46	\$10,100	1997	\$10,100	0.51	\$6,761	1.2			WT306	1.12
F-300	4	0	Fermentors	GALLONS	750,000	750,000	1.00	\$326,203	1999	\$1,304,812	0.71	\$1,304,812	1.8		\$1,304,812 750,000 gal. each, 2 day residence total, 90% wv, API, atmospheric, 50' f x 5		
-301	2	0	1st Fermentation Seed Fermentor	None		0	0.45	\$14,700	1997	\$29,400	0.93	\$13,991	2.8	\$39,948	\$14,267 9 gal, jacketed, agitated, 1' dia., 1.5' high, 15 psig	ì	
-302	2	0	2nd Fermentation Seed Fermentor	None		0	0.45	\$32,600	1997	\$65,200	0.93	\$31,027	2.8		\$31,640 90 gal., jacketed, agitated, 2' 3" dia., 3' high, 2.5 psig	{	
-303	2	0	3rd Fermentation Seed Fermentor	None		0	0.45	\$81,100	1997	\$162,200	0.93	\$77,186		\$220,394	\$78,712 900 gal., jacketed, agitated, 5' dia, 6,5' high, 2,5 psig	1	
-304	2	0	4th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$39,500	1997	\$79,000	0.93	\$35,225		\$60,174	\$35,921 9000 gal., 9' dia x 19' high, atmospheric	1	
-305	2	0	5th Fermentation Seed Fermentor	STRM0304	41,777	17,529	0.42	\$147,245	1998	\$294,490	0.51	\$189,107		\$336,910	\$191,360 90000 gal., API, atmospheric 25'f x 25'	{	
1-300	4	1	Fermentation Cooler	QHX300EA	67,820	25.053	0.37	\$4,000	1997	\$20,000	0.78	\$9,198		\$20,438	\$9,380 4 exchangers at 221 sf, U=300 BTU/hr sf F LMTD = 22.9°F plate and frame	ł	
1-301	1	0	Fermentation Seed Hydrolyzate Cooler	AREA0301	773	318	0.41	\$15,539	1998	\$15,539	0.78	\$7,778		\$17,151	\$7,871 348 sf, 300 BTU/hr sf F	{	
1-302	1	0	Fermentation Pre-Cooler	AREA0302	3,765	828	0.22	\$25,409	1998	\$25,409	0.78	\$7,797	2.2		\$7,890 828 sf total, plate and frame	ļ	
-304	1	Ō	4TH Seed Fermentor Coils	QSDF0301	38,339	15,789	0.41	\$3,300	1997	\$3,300	0.83	\$1.580	1.2		\$1,611 12 sf, 1" sch 40 pipe, 105 BTU/hr sf F		
1-305	1	0	5TH Seed Fermentor Coils	QSDF0301	38.339	15,789	0.41	\$18,800	1997	\$18,800	0.98	\$7,881	1.2	\$9,644	\$8,037 138 sf, 2" sch 40 pipe, 92 BTU/hr sf F		
-300	4	ī	Fermentation Recirc /Transfer Pump	QHX300EA	67.737	55,505	0.82	\$8,000	1997	\$40,000	0.79	\$34,177	2.8	\$97,307	\$34,852 844 gpm @ 150 ft sized based on heating rate		
-301	1	1	Fermentation Seed Transfer Pump	STRM0304	41.777	17,529	0.42	\$22,194	1998	\$44,388	0.73	\$24,168		\$34,238		WP300	104.49
2-302	2	0	Seed Transfer Pump	STRM0304	41.777	17,529	0.42	\$54,088	1998	\$108,176	0.7	\$58,898		\$83,440	\$59,600 504 gpm (d) 150 ft head	WP301	5.95
2-306	1	1	Beer Transfer Pump	STRM0502	381.701	173.737	0.46	\$17,300	1997	\$34,600	0.79	\$18,579		\$52,899		WP302	7.14
r-301	1	0	Fermentation Seed Hold Tank	STRM0304	41,777	17,529	0.42	\$161,593	1998	\$161,593	0.79					WP306	34.47
-306	<del></del>	0	Beer Well	STRM0502	129,000	183,467	1.42	\$111,889	1998		0.51	\$103,767	1.8	\$184,870	\$105,003 105000 gal., API atmospheric		
500	L		Deer vven	1 21KM0302 ]	129,000	1 103,467	1.42	\$111,009	1993	\$111,889		\$133,906	1.8	\$235,756	\$133,906 192,518 gal., 32' dia x 32' high, 4 hr. res. time, 95% wv. atmospheric		
300									Subtotal	weighted averages: \$2,742,935	0.6843466	\$2,240,795	1.8	\$4,028,307	\$2,255,629		373.53
						2	2000tpd x	: .45 (current y	ear cost v	with area weighted-ave	erage scale e		1.3	\$8,218,509	\$4,190,202 is installed cost savings		
A-307	8	0	Enzymatic Hydrolysis Tank Agitators	STRM0302B	157,136	157,136	1.00	\$19,676	1996	\$157,408	0.51	\$157,408	1.2	\$199,666	\$162,539 two side mounted 75 hp agitators / tank, 0.4hp/1000 gat.	WT307	251.67
4-307	12	0	Enzymatic Hydrolysis Tank Heater	STRM0302B	157,136	157,136	1.00	\$15,000	1999	\$180,000	0.78	\$180,000	2.2	\$392.214	\$180,000 65 ft2 double pipe	,	257.57
1-308	1	0	Pre-hydrolyzate cooler	STRM0302	145,536	145,536	1.00	\$25,000	1999	\$25,000	0.78	\$25,000	2.2	\$54,474	\$25,000 481 ft2, parallel double pipe		
-308	8	1	Hydrolyzer Bottoms Pump	STRM0302B	157,136	157,136	1.00	\$121,690	1999	\$1,095,210	0.6	\$1,095,210	1.2	\$1,314,252		WP308	1,744.94
				i i										*1,123,133	375,000 gallons, 24 hour residence time, 2 side mounted agitators cone	11. 200	1,744.54
-307	4	0	Enzymatic Hydrolysis Tank	STRM0302B	750,000	375,000	0.50	\$326,203	1999	\$1,304,812	0.6	\$860,855	2.0	\$1,753,728	\$860,855 bottom, concrete base, bottom outlet through the concrete, 300 cone bottom		
0	0	0	0	0	0	0	0.00	\$0	1999	\$0	0	\$0		\$0	\$0 0		
											0.6082295	•••	1.6		4010		1,996,61
rea 307								5	Subtotal	\$2,762,430	0.0001155	\$2,318,473	, ,,,	\$3,714,334	\$2,323,604		1,930.01
										*-,,		2000tpd x .45 (c)		\$0	(\$3,714,334) is kistalled cost savings		
						,						2000tpd X .43 (C		\$0	(55,714,554) is assauce costs straigs assumed to be adequate equipment for distribution and storage of purch	hased enz	VIII:6
			Cellulase Transfer Pump (assumed														
			same as reference model recycle water			1											
-420	1	1	pump)	STRM0602	179,446	84,120	0.47	\$10,600	1997	\$21,200	0.79	\$11,652	2.8	<b>\$</b> 33,175	\$11,882 370 gpm, 150ft head	WP630	14.75
			Cellulase Storage Tank Agitators														
- 1			(assumed same as study model			ŀ					1						
401	2	0	fermentor agitators)	GALLONS	962.651	750,000	0.78	\$19,676	1996	\$39.352	0.51	\$34.648		*43.050	275 277 Cid. March 1 2		
				-,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	302,001	730,000	0.70	\$13,070	1330	\$38,352	V.51	\$34,648	1.2	\$43,950	\$35,777 Side Mounted, 2 per vessel, 60 hp each, 0.15 hp/1000 gai	WT401	67.11
			Cellulase Storage Tank (assumed			1					ŀ						
700		_	same as study model production	l l			. 1				ŀ				750,000 gal., 34 hr supply by purchase projection method "A" or 42 hr		
-708		0	fermenter)	GALLONS	750,000	750,000	1.00	\$326,203	1999	\$326,203	0.71	\$326,203	1.8	\$574,315	\$326,203 supply by purchase projection method "B", API, atmospheric, 50" \( \psi \times 51' \)		
400											ar	ea install factor	1.7				81.87
400								\$	ubtotal	\$386,755		\$372,503		\$651,440	\$373,863		
												2000tpd x .45	1.3	\$7.057.277	\$6,405,837		

						2	x bqt000	.45 (current ye	ar cost v	vith area weighted-ave	age scale ex	onent applied)	1.3	\$5,167,342	(\$4,656,910) is installed cost savings		
0								s	ubtotal	\$9,558,715		\$9,542,206		\$9,824,251	\$9,556,310	I	1,00
				*						weighted averages:		40,234	1.0	913,332	40,000 j. 410 gai, 20 min. res., 2.0 psig, 3.0n ulani. x 14.20n		1,60
0 1		0	Recycled Water Tank	STRM0602	179,446	84,120	0.47	\$14,515	1998	\$14.515	0.00	\$8,254	1.7	\$13,992	\$8,353 7410 gal, 20 min. res., 2.5 psig, 9.5ft diam, x 14,25ft	WS601	+5
1 2		0	Beer Column Bottoms Centrifuge	CENTFLOW	404	300	0.74	\$659,550	1998	\$1,319,100	0.60	\$1,103,371	1.2	\$1,339,824	\$11,862,370 gpm, 150ft head \$1,116,520 requires 540gpm duty, 2 @ 300 gpm and 410 hp each	WP630	1 . 43
10 1	-+-	1	Recycle Water Pump	STRM0602	179,446	84,120	0.47		1997	\$21,200	0.79	\$11,652	2.8	\$288,825 \$33,175	\$288,825 acquire an NPDES permit \$11,882 370 gpm, 150ft head	AIDEAR .	
18 1		0	Pressure Sand Filters	STRM0830	98.267	102,204	1.04	\$280,000	1999	\$280,000	0.79	\$288,825	1.0	#200 B26	400 ft2 of fittration surface area, includes the engineering and legal cost to		
1/   1			Aerobic Digestion System	STRM0830	98,267	102,204	1.04	\$4,300,000	1999	\$4,300,000	0.79	\$4,435,520	1.0	\$4,435,520	\$4,435,520 approximately 1,400 horsepower		
17 1	Ì	0	In the City of the Country of the City of										-	ł	capability, de-nitrification facilities, aeration and mixing requires		
											į.	[	E		four-350,000 gal. Sequencing Batch Reactors, 48,000 lbs/day of O2 transfer	1	
10 1		0	Anaerobic Digestion System	STRM0830	98,267	102,204	1.04	\$3,200,000	1999	\$3,200,000	0.79	\$3,300,852	1.0	\$3,300,852	\$3,300,852 500,000 gal., includes site work, foundations, reactors and ancillary equipment	nt	
16 1		- 0	Equalization Basin	STRM0830	98,267	102,204	1.04	\$350,000	1999	\$350,000	0.79	\$361,031	1.0	\$361,031	\$361,031 foundations, pumps and controls	WM615	13
15 1			L	1 1											no less than 500,000 gal., above-ground bolted tank with cover, including	1	
14 1	-+-	0	Lignin Loadout	STRM0601A	63,778	0	0.00	\$41,200	1999	\$41,200	0.30	\$0	1.0	\$0	\$0 245 GPM @ 20.6% insoluble solids	1	
14 1	-+-	- 0	Syrup Sprayer	STRM0531	22,372	22,372	1.00	\$1,000	1999	\$1,000	0.30	\$1,000	1,2	\$1,200	\$1,000 100 GPM syrup sprayer	1	
1 1	+	0	Lignin conveyor	STRM0601B	225,140	225,140	1.00		1997	\$31,700	0.60	\$31,700	1.5	\$49,832	\$32,327 14" dia. 100' long	WC109	
			In the second se								-						
						2	ODDtod v			vith area weighted-ave	rano enalo ov		1.7	\$6.765.614	(\$749,972) is installed cost savings		
0								9	ubtotal	\$6,343,492	J., 197332	\$4,301,097	1.7	\$7,515,486	\$4,400,972	L	-
			- A				1.55	\$33,020		weighted averages:		433,320	1.7	\$101,304	300,020 TO hold' on that tea mus		
3 1		0	Kill Tank	STRM0518	149,897	149,897	1.00	\$99,920	1999	\$99,920	0.78	\$99,920	1.7	\$167.384	\$99,920 18 psig, 30 min, res. time	1	
2 1		0	Vent Scrubber	STRM0523	18,523	9,788	0.53	\$99,000	1998	\$99,000	0.78	\$60,197	1.7	\$102,043	\$60,915   5' dia x 25' high, 4 stages, plastic Jaeger Tri-Packing		
5 1		0	Reclification Column Reflux Drum	QCND0502	4,906,301	2,323,304	0.47	\$45,600	1997	\$45,600	0.72	\$26,621	1.7	\$45,476	\$27,147 6225 gal, 15 min res time, 50% wv, 7' dia, 22' long, 25 psig	1 :	
3 1		0	Beer Column Relfux Drum	QCND0501	277,820	131,557	0.47	\$11,900	1997	\$11,900	0.93	\$5,938	1.7	\$10,144	\$6,055 164 gal, 15 min res. Time, 50% wv, 2'6" dia., 5' long, 25 psig	JEEP 31.7	
7 1		1	Kill Tank Bottoms Pump	STRM0518	5,053	660	0.13	\$42,300	1997	\$84,600	0.79	\$16,944	2.8	\$48,242	\$17,279 660gpm, 72 ft head	WP517	
5 1		1	Scrubber Bottoms Pump	STRM0551	15,377	7,427	0.46	\$2,793	1998	\$5,586	0.79	\$3,143	2.8	\$6,881	\$3,181 31 gpm, 104 ft head	WP515	
4 1		1	Evaporator Condensate Pump	STRM534A	140,220	69,285	0.49	\$12,300	1997	\$24.600	0,79	\$14,095	2.8	\$40,131	\$14,374 293 gpm, 125 ft head	WP514	
3 2	2 ].	1	3rd Effect Pump	STRM0531	48,001	23,814	0.50	\$8,000	1997	\$24,000	0.79	\$13,795	2.8	\$39,276	\$14,068 196 gpm each, 110 ft head	WP513	
2 1		1	2nd Effect Pump	STRM052B	91,111	45,390	0.50	\$13,900	1997	\$27,800	0.79	\$16,032	2.8	\$45,646	\$16,349 599 gpm, 110 ft head	WP512	
1 2	2	1	1st Effect Pump	STRM0525	278,645	133,617	0.48	\$19,700	1997	\$59,100	0.79	\$33,069	2.8	\$94,155	\$33,723 1137 gpm each, 110 ft head	WP511	
5 1		- 1	Rectification Column Reflux Pump	QCND0502	4,906,301	2,323,304		\$4,782	1998	\$9,564	0.79	\$5,299	2.8	\$14,970	\$5,362 207 gpm, 110 ft head	WP505	
4 1		1	Rectification Column Bottoms Pump	STRM0516	31,507	15,530	0.49	\$4,916	1998	\$9,832	0.79	\$5,622	2.8	\$15.884	\$5,689 76 gpm, 158 ft head	WP504	
13 1		1	Beer Column Reflux Pump	QCND0501	277,820	131.557	0.47	\$1,357	1998	\$2,714	0.79	\$1,504	2.8	\$4,248	\$1,522 6 gpm, 140 ft head	WP503	
01 1	1	1	Beer Column Bottoms Pump	P501FLOW	5,053	2.200	0.44	\$42,300	1997	\$84,600	0.79	\$43,861	2.8	\$124,881	\$44,728 2200 gpm, 150 ft head	WP501	
03 1	1	0	Molecular Sieve (9 pieces)	STRM0515	20,491	9.703	0.47	\$2,700,000	1998	\$2,700,000	0.7	\$1,599,964	1.0	\$1,619,030	\$1,619,030 vacuum source.	WM503	
<del>-  </del>	-	<u> </u>	3.77	1 411213311	0,704,222	0,200,000		\$121,510	1330	\$243,132	0.00	\$140,237	2.2	\$329,077	Superheater, twin mole sieve columns, product cooler, condenser, pumps,	1	
17 1	1	1	Evaporator Condenser	QHET0517	6,764,222	3,203,095	0.47	\$121.576	1996	\$243,152	0.68	\$146,257	2.2	\$329.077	\$23,6521431 \$1, 200 B1 U/hr st F \$151,024 Fixed TS, 3906 st, 29" dia., 20" long, 220 BTU/hr st F	1	
12 1	<del></del>	1	Beer Column Feed Interchange	AREA0512	909	430	0.47	\$19,040	1996	\$38,080	0.68	\$22,905	2.2	\$51.537	\$53,524 Fixed TS, 1969 sf, 29" dia, 20' long, 157 BTU/hr sf F \$23,652 431 sf, 200 BTU/hr sf F	1	
05 1	<del>i  </del>	- 0	Rectification Column Condenser	QCND0502	4,905,410	2,322,883	0.47	86,174	1996	\$86,174	0.68	\$51,834	2.2	\$116,626	\$18,350 Floating Head, 418 sf, 15" dra., 22" long, 92 BTU/hr sf F		
04 1	-	0	Beer Column Condenser	QCND0501	277,820	131,557	0.47	29,544		\$29,544	0.68	\$17,805 \$17,771	2.2	\$39,563 \$39,984	\$18,157 Thermosyphon, 512 sf, 15" dia., 20" long, 130 BTU/hr sf F	1	
02 1	<del>i  </del>	0	Rectification Column Reboiler	QRFD0502	-987,427	-467,581	0.47	\$29,600	1997	\$29,600	0.68		2.2		\$98,368 Fixed TS, 6602 sf, 31" dia., 20" long, 178 BTU/hr sf F	-	
01 1	<del>i</del> +		Beer Column Reboiler	QRFD0501	-7,863,670	-3,723,722		\$158,374	1996	\$158,374	0.68	\$95,263	2.1	\$214,340	\$449,850 22278 sf each., 170 BTU/hr sf F		
03 1	it	0	3rd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650	1996	\$435,650	0.68	\$435,650		\$944,685		4	
02 1	<del>i  </del>	0	2nd Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,650		\$435,650	0.68	\$435,676	2.1	\$944,742 \$944.685	\$449,877 22278 sf each., 135 BTU/hr sf F \$449.850 22278 sf. 170 BTU/hr sf F	1	
01 1	i	- 0	1st Effect Evaporation	AREA0502	22,278	22,278	1.00	\$435,676		\$525,800 \$435,676	0.78 0.68	\$293,491 \$435,676	2.1	\$636,421	\$303,058 8' dia.(rect)., 4' dia. (strip) x 18" T.S., 60 act. Trays, 60% eff., Nutter V-Grid tr	ays	
02 1		0	Rectification Column	S510S521	56,477	26,744	0.47	\$525,800	1996	4505.000		\$402,792	2.1	\$873,434	\$415,921 7'6" DIA, 32 ACTUAL TRAYS, NUTTER V-GRID TRAYS	J	

P-703	1	1	Sulfuric Acid Pump	STRM0710	1,647		.16	\$8,000 19			\$18,001	2.8	\$51,253	\$18,357 215 gpm, 150ft head		0.09
P-720	1	1	CSL Pump	STRM0735	2,039		).42		97 \$17,600	0.79	\$8,889	2.8	\$25,308	\$9,065 182 gpm, 150ft head	WP720	0.15
T-703	1	0	Sulfuric Acid Storage Tank	STRM0710	1,647				97 \$42,500	0.51	\$45,860	1.8	\$82,338	\$46,767 20,000 gal, 240 hr supply, 90% wv, 12ft diam. x 24 ft, atmospheric	<b></b>	
T-720	1	1 0	CSL Storage Tank	STRM0735	2,039	859 0	1.42	\$88,100 19	97 \$88,100		\$44,495	1.7	\$76,011	\$45,375 30160 gal, 90% wv, 120 supply, 14.3ft diam, X 25 ft	7	
ł.										A?	ea install factor	2.0			⊣	0.24
									\$164,200				\$234,910	\$119,563	1	
100								Sub	otal		2000tpd x .45	_	\$819,339	\$584.429		
, ——.	,															
		1												200,000 #/hr running @ 171,488 #/hr; with 40,000 #/hr 160o superheat;	7	
M-803	1	0	Boiler with Superheater	M0815 + 216	200,000	200,000		1,590,000 19		0.7	\$1,590,000	1.3	\$2,067,000	\$1,590,000 132,000#/hr 390o sat, @ 205 psig	WM803	75.60
M-820	1	0	Hot process water softener system	STRM0811B	229,386			,383,300 19		0.6	\$520,623	1.2	\$624,748	\$520,623 200 gpm		
M-830	1	0	Hydrazine Addition Pkg.	STRM813A	229,386			\$19,000 19		0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal tank, agitator, 2 metering pumps	WM830	10.00
M-832		0	Ammonia Addition Pkg	STRM813A	229,386			\$19,000 19		0.6 0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal tank, agitator, 2 metering pumps	WM832	10.00
M-834 P-804		0	Phosphate Addition Pkg.	STRM813A	229,386			\$19,000 19		0.6	\$10,139	1.0	\$10,857	\$10,857 75 gal tank, agitator, 2 metering pumps	WM834 ·	10.00
P-804	2	1-1-	Condensate Pump	STRM811A	249,633		.16	\$7,100 19		0.79	\$4,894	4.6	\$22,958	\$4,991 130 gpm, 150' head	WP804	9.21
	2	1	Deaerator Feed Pump	STRM811A	196,000		.20	\$9,500 19		0.79	\$7,927	8.3	\$67,097	\$8,084 180 gpm, 115' head	WP824	4.89
P-826	4	1	BFW Pump	STRM0813	207,310	80,536	0		98 \$262,505	0.79	\$124,377	1.4	\$176,203	\$125,859 310 gpm, 2740' head	WP826	400.99
P-828	1	1	Blowdown Pump	STRM0821	6,600	2,699	0		997 \$10,200	0.79	\$5,032	6.4	\$32,842	\$5,132 12 gpm, 150' head	WP828	0.42
P-830		1	Hydrazine Transfer Pump	STRM813A	229,386	80,536	0	5,500 19		0.79	\$4,811	6.4	\$31,402	\$4,907 3 gpm, 75' head	WP830	0.05
T-804 T-824		0	Condensate Collection Tank	STRM811A	229,386	38,798	0	7,100 19		0.71	\$2,011	3.3	\$6,766	\$2,050   200 gal, 1.5 min. res. time	1	
T-826	!	0	Condensate Surge Drum	STRM811A	150,000			\$49,600 19		0.72	\$18,734	5.0	\$95,523	\$19,105 2100 gal., 6' diam. X 10', 15 psig, res. time 11 min.	7	
T-828		0	Deaerator	STRM0813	267,000			165,000 19		0.72	\$69,616	6.5	\$457,896	\$70,446 3030 gal., 15 psig. 10 min. res.	7	
T-830	1	0	Blowdown Flash Drum	STRM0821	6,550			\$9,200 19		0.72	\$4,859	7.3	\$36,168	\$4,955 210 gal., 2.5' diam. X 6', 50 psig 17 min. res.		
[1-630		1 0	Hydrazine Drum	STRM613A	229,386	80,536 0	.35	\$12,400 19			\$4,685	7.0	\$33,440	\$4,777 13B gal, 3.75' x 1.25' diam., 10 psig	7	
A800									weighted averages:	0.6704429		1.5			-1 -	521.16
AGUU								Subt			\$2,387,986		\$3,684,612	\$2,393,497		
						2000	tpd x .45 (	current year o	ost with area weighted-av	erage scale ex	xponent applied)	1.1	\$23,046,972	\$19,362,360 is installed cost savings		
M-902		ń	12											<u> </u>		
M-902		0	Cooling Tower System	QCWCAPIT		12,955,985 0		659,000 19		0.78	\$674,181	1.2	\$818,659	\$682,216 40,000 gpm, 185.4MM BTU/hr	VVM902	298.85
M-908			Plant Air Compressor	STRM0101	159,950			\$60,100 19		0.34	\$60,100	1.3	\$79,675	\$61,288 450 cfm, 125 psig outlet	WM904	186,40
M-908		0	Chilled Water Package	QCHLWCAP		2,268,000 0		380,000 19		0.8	\$200,610	1.2	\$245,492	\$204,577 1000 ton, 600kW	WM908	600.00
P-902			CIP System	STRM0914	63			\$95,000 19		0.6	\$58,837	1.2	\$73,021	\$60,851 designed by Delta-T, (est 0.2 kW)	WM910	0.20
P-912			Cooling Water Pumps	STRM0940	18,290,000			332,300 19		0.79	\$259,201	2.8	\$737,993	\$264,326 12300 gpm, 70ft head	7	
P-914			Make-up Water Pump	STRM0904	244,160			\$10,800   19		0.79	\$9,161	2.8	\$26,084	\$9,343 370 gpm, 75ft head	WP912	7.32
5-904	- ;		Process Water Circulating Pump	STRM0905	352,710	111,503 0.		\$11,100   19		0.79	\$8,938	2.8	\$25,449	\$9,115 745 gpm, 75ft head	WP914	14.78
T-904			Instrument Air Dryer	STRM0101	159,950	71,977		\$15,498 19		0.6	\$19,197	1.3	\$24,956	\$19,197 134 scfm air dryer, -40F Dewpoint	WS601	4.91
		0	Plant Air Receiver	STRM0101	159,950	53,316			997 \$13,000	0.72	\$5,894	1.7	\$10,069	\$6,011 300 gal., 200 psig	7	
T-914	1	0	Process Water Tank	STRM0905	352,710	111,503	0	195,500 19	97 \$195,500	0.51	\$108,663	1.8	\$195,095	\$110,811 234360 gal, 8hr res. time	7	
A DOD															_ r	1,112,46
Area 900								Subt			\$1,404,783		\$2,236,491	\$1,427,733	Total kw	6,759
						2000	tpd x .45 (	current year c	ost with area weighted-av	erage scale ex	(ponent applied)	1.3	\$5,278,320	\$3,041,829 is installed cost savings		

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	PLANT TOTAL:		\$50,551,364	\$37,985,885	\$52,991,432
45	A NREL TOTAL:		그리고 하는 집 개를 가겠다		\$74,560,389
	SAVINGS:				\$21,568,856
<u> </u>		 SUBSECTION NO. 1	The Control of the Co	KERD KIND DODE HE	28.93%

outilitially conditional

#### Comparison of On-Site Cellulase Production via Pure Vision Technology and NREL Reference Model, to Purchase of Commercially Available Enzyme

#### CURRENT ASSUMPTION: BASED ON PRODUCT SPECIFICATIONS PROVIDED BY SPECIALTY ENZYMES INC.

		NRE	<u>L*</u>			Pur	e Vision		Purc	chased Cellulase ***
		MF	PU required/yr**		difference	MF	PU required/yr	difference	MF	PU required/yr
			1,446,984		(50,708)		1,497,692	56,431		1,554,123
perating Projection:		*								
gal of fuel grade ethanol produced		\$	25,434,849	\$	(311,275)	\$	25,746,124	\$ 933,825	\$	26,679,948
Contract sale price per gallon		\$	1	\$	-	\$	1	\$ -	\$	1
Gross Annual Revenue		\$	27,978,334	\$	(342,402)	\$	28,320,736	\$ 1,027,207	\$	29,347,943
Small Ethanol Producer Tax Credit										
@ \$ - per gallon		\$	-			\$	-	•	\$	-
Total projected ethanol sales and credit		\$	27,978,334	\$	(342,402)	\$	28,320,736	\$ 1,027,207	\$	29,347,943
Gross Annual Co-Product Revenue		\$	328,822	\$	-	\$	328,822	\$ -	\$	328,822
Gross Sales and Credit		\$	28,307,156	\$	(342,402)	\$	28,649,558	\$ 1,027,207	\$	29,676,765
Operating Expenses:										
Utilities		\$	4,792,171	\$	567,400	\$	4,224,771	\$ (1,803,557)	\$	2,421,214
Raw Materials		\$	12,843,241	\$	96,523	\$	12,746,718	\$ 492,822,759	\$	505,569,478
Processing Materials		\$	267,948	\$	66,987	\$	200,961	\$ (200,961)	\$	-
Operation & Maintenance		\$	6,414,114	\$	70,428	\$	6,343,686	\$ (505,618)	\$	5,838,069
Property Tax @ 0.50% Book Value		\$	486,736	\$	57,315	\$	429,421	\$ (28,534)	\$	400,888
Depreciation		\$	6,038,644	. \$	744,902	\$	5,293,743	\$ (340,048)	\$	4,953,694
Total Operating Expense		\$	30,842,855	\$	1,603,554	\$	29,239,301	\$ 489,944,041	\$	519,183,342
Net Operating Income		\$	(2,535,699)	\$	(1,945,956)		(589,742)	\$ (488,916,834)	\$	(489,506,577)
								\$ -		, , , ,
Net Operating Cash Flow		\$	3,502,945	\$	(1,201,055)	\$	4,704,000	\$ (489,256,883)	\$	(484,552,883)
enzyme cost (cost of production										
calculated in "\$per lb. calcs.") divided by								* =		
lbs. per year flow rate from mass balance.	\$/Ib	\$	0.027			\$	0.020		\$	2.413
<pre>enzyme cost (cost of production calculated in "\$per lb. calcs.") divided by</pre>										
million FPU per year required.	\$/MFPU	\$	4.60	•		\$	3.32		\$	182.89
· ·									_	

Annual Savings Using PureVi	sion On-Site Enz	yme Production
OVER REFERENCE MODEL: \$	1,201,055	
OVER PURCHASED ENZYME: \$	489,256,883	

^{* 45%} scale factor applied, SHCF

^{* *} MFPU = million FPU

^{***} Specialty Enzymes, Liquicell 2500, \$2.00/lb, S.G. 1.100, 32 FPU/ml. 14.7

#### PLAINS YORK MODEL WITH PURCHASED CELLULASE FOR COMPARISON OF ON-SITE ENZYME PRODUCTION VS. PURCHASED GAIN IN ETOH PRODUCTION POSSIBLE:

332 kg/hr

10/27/99

#### ENZYMATIC HYDROLYSIS - PRO FORMA

lying Assumptions & Input Variables

JRRENT SITUATION:

The Pro Forma models an Enzymatic Hydrolysis Ethanol plant using corn stoyer as the

**ETHANOL** 

The plant will convert corn stover to fuel grade ethanol utilizing enzymatic hydrolosis.

Corn stover feed rate of

71,977 kg/hr (str 101), produce estimated total output in

equivalent kilograms of fuel grade ETOH

9.483 ka/hr. = 79,659,865 kg / year (str 515)

gal./short ton=

76.8

3.176 gal/hr =

26,679,948 gal / year

gal./metric ton=

84.7

Increase to current York yearly production:

72%

The model assumes renewal of the ethanol excise tax credit of \$.54 per gallon to the blender and NOT the small producer tax credit of \$.10 per gallon through the year 2015 for a total ethanol value of

\$1.10 per gallon or

\$0,37 per kg and

\$ 29,347,943 per year TOTAL Ethanol sales

CARBON DIOXIDE

Currently, carbon dioxide from the High Plains York fermentations is sold to a CO₂ compression company.

Diverting the CO₂ (stm 550) from the stover plant into this stream for sale as opposed to the atmosphere provides

110,749 kg/hr =

930,294 ton / year

with a value of \$

4.13 per metric ton

WITH THIS PROFORMA NO CO2 IS SOLD. CO2 Value/year = \$0

LIGNIN

A Lignin co-product is produced and sold as combustion fuel material. A total amount of lignin in the stream (stm 601B) is

63,778 kg/hr =

535,734 metric ton / year is produced from the process.

The water in the lignin stream must be vaporized at a net BTU cost for the stream (stm 601B). Water vaporized is 43,969 kg/hr =

369,337 metric ton/year is vaporized at 1,100 BTU/lb loss =

(107) MM BTU/hr

The remaining

19,809 kg/hr of stream 601B has

Total heating value from stream 601A is

24,251 BTU/kg value =

480 MM BTU/hr 374 MM BTU/hr

Gross Lignin Value/year = \$7,848,926

Transport Cost = \$7,848,926

Net Lignin Value = \$0

METHANE

The digester produces 85% methane @

353 kg/hr (stm 615)

Total heating value from Methane is

44,332 BTU/kg CH4 16 MM BTU/hr

methane is used in the DDG dryers and based on BTU value of

\$2.50 MM BTU

METHANE Value/year = \$328,822

DIGESTER SLUDGE

The digester produces (stm 623)

0 kg/hr of sludge as fuel =

2,254 BTU/lb

based on 9,845 btu/lb biomass and 70% water in the sludge.

4,969 BTU/kg

Total heating value from sludge is

0.00 MM BTU/hr

SLUDGE Value/year = \$0

Sale of methane and lignin, based on BTU value is

\$328,822 per year

Total projected facility sales would be

\$29,676,765 per year

## APITAL INVESTMENT ASSUMPTIONS

Total capital investment			
Civil Structural		(500,000)	
Area 100		6,146,434	
Area 200		14,955,166	
Area 300		4,028,307	
Area 307		3,714,334	
Area 400	651,440		
Area 500		7,515,486	
Area 600		9,824,251	
Area 700		234,910	
Area 800		3,684,612	
Area 900		2,236,491	
Fixed Capital		\$52,491,432	
INDIRECTS Prorateable	3.5%	\$1,837,200	
Process Development	2.0%	\$1,049.829	
Field Expense	8.0%	\$4,199,315	
Home Office Constr. Fee	12.0%	\$6,298,972	
Contingency	10.0%	\$5,249,143	
Start-up, Permits, Fees	3.0%	\$1,574,743	
Working Capital per estimate		\$42,617,296 1 mos Raw matls. + O&M	
	Total Plant Cost	\$115,317,929	
FEDERAL & STATE GRANTS	10%	(\$11,531,793)	
	Net Capital Investment	\$103,786,136	

PERATING COST ASSUMPTIONS 8,400 hr/yr

Utilities (Rates based on	26,679,948 gal/yr produced)				
	<u>Amount/hr</u>	<u>Units</u>	<u>\$/unit</u>	Cost /hr.	Total Cost /yr
*Electricity	6,759	Kw-hr	\$0.035	\$237	\$1,987,079
Well water	79,972	kg	\$0.000	\$0	\$0
*Wastewater	39,119	kg	\$0.00026	\$10	\$86,808
*Gypsum waste disposal	1,137	kg	\$0.0364	\$41	\$347,327
		mTon	\$1.103	\$0	\$0
Total Utilities				\$288	\$2,421,214
* Ouoted by High Plains					

Raw Material Costs							
	<u>Amount/hr</u>	<u>Units</u>		\$/unit	Cost /hr.		Total Cost /yr
Corn Stover DRY (stm 101 less water)	37,500	kg		\$0.680	\$25,499.90		\$214,199,143
*Sulfuric Acid (stm 710)	860	kg		\$0.100	\$86.26		\$724,592
*Calcium Hydroxide (Lime stm 227)	337	kg		\$0.293	\$98.70		\$829,039
*Ammonia (stm 717)	387	kg		\$0.162	\$62.77		\$527,281
Corn Steep Liquor (stm 735)	708	kg		\$0.051	\$36.10		\$303,280
Nutrients (stm 415)	0	kg		\$0.291	\$0.00		\$0
Purchased Cellulase	14,021	lbs		\$2.000	\$28,041.97		\$235,552,564
transport cost	750	miles		\$3.000	\$2250 /load		\$48,684,298
*Natural Gasoline (stm 701)	391	kg		\$0.155	\$60.36		\$506,988
*Rolling Stock Gasoline	79	kg		\$0.155	\$12.32		\$103,470
*WWT Chemicals	5	kg		\$0.000	\$0.00		\$0
*CW Chemicals	17	kg		\$0.000	\$0.00		\$0
*BFW Chemicals	73.8	kg		\$0.226	\$16.65		\$139,833
*Boiler Fuel (stm 813)	190	Mbtu		\$2.500	\$476.07		\$3,998,989
Total Raw Materials					\$54,391		\$505,569,478
* Quoted by High Plains							, , , , , ,
Processing Material Costs							
	<u>Amount/hr</u>	<u>Units</u>		<u>\$/unit</u>	<u>Cost /hr.</u>		Total Cost /yr
*Antifoam (Corn Oil)	0	kg		\$0.304	\$0	· · · · · · · · · · · · · · · · · · ·	\$0
Total Processing Materials * Quoted by High Plains					\$0		\$0
Operations and Maintenance Costs - DRY HAN	IDLING (area 100)	each/day		wage	hr/day each		Total Cost /yr.
*Supervisors		0.5	\$	20.00	12		\$43,800
*Operators		2.0	\$	16.00	12		\$140,160
*Laborers		8.0	\$	16.00	12 .		\$560,640
*Maintenance		2.0	\$	16.00	12		\$140,160
Operations and Maintenance Costs - HYDROL	YSIS/FERMENTATION	DN (area 200	, 300,	400, 500, 6	<u>00</u> )		
*Supervisors		1.0	\$	20.00	12		\$87,600
*Operators		8.0	\$	16.00	8		\$373,760
*Laborers		4.0	\$	16.00	8		\$186,880
*Technicians (Includes Lab.)		3.0	\$	16.00	8		\$140,160
*Maintenance		3.0	\$	16.00	8		\$140,160
Operations and Maintenance Costs - Utilities (a	rea 700, 800, 900)						
*Supervisors		0.5	\$	20.00	12		\$21,900
*Operators		3.0	\$	16.00	8		\$70,080
*Laborers		1.0	\$	16.00	8		\$23,360
*Technicians		1.0	\$	16.00	8		\$23,360
*Maintenance		2.0	\$	16.00	8		\$46,720
* Quoted by High Plains Standard HPY	shifts are 12 hours.						
	Total Operations an	nd maintenan	ce lab	oor costs			\$1,998,740
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3.0%

699,559

131,229

262,457

524,914

262,457 799,496

109,388

\$5,838,069

1,049,829

Other Operations and Maintenance Costs				
Payroll Overhead	35% of operating labor			
Maintenance Costs	2% of plant cost			
Operating Supplies	0.25% of plant cost			
Environmental	0.50% of plant cost			
Local Taxes	1% of plant cost			
Insurance	0.50% of plant cost			
Overhead Costs	40% of labor, supervision,maint cost			
Administrative Costs	1% of annual sales (less tax credits)			
Distribution and Sales	0.5% of annual sales (less tax credits)			
Total O&M Costs				
THER MODEL ASSUMPTIONS				
verage prevailing market price of fuel grade ETOI	H;		\$0.37 per kg	
ssumes renewal of the ethanol excise tax credit of	of \$.54 per gallon		\$ 1.10 per gallon	
nd the small producer tax credit of \$.10 per gallon	through the year 2007		The same of the control of the contr	
Value of CO ₂ produced			\$ 4.13 per metric ton	
Price for Electricity			\$ 0.035 per KWhr	
Gas price per million BTU			\$ 2.500 per MM BTU	
<i>7</i> .		•	- Commence of the second states of the second secon	
orn Stover feedstock cost- dry basis/short ton			Dry matter	
on Stover leedstock cost- dry basis/short ton	\$ 14.45	\$0.016	•	
		\$15.93	per metric ton	
and an other ore factor			Transinta kenjarah projespoje kensa mengangka makana.	
ant on-stream factor			0.959	
ant operating hours per year			8,400	
epreciable Life of Capital Equipment			15 years	
verage annual commodity escalation rate:			3.0%	

Pfpve

rerage annual cost escalation rate:

There are no land acquisiton costs included. There are no off site costs included (e.g. public road

There exist adequate roads and rail roads to allow

The costs for air and water permits are not included. Soils are adequate for conventional foundation designs.

improvements, extensions of power, water, telephone services) There is a source of qualified construction personnel within daily

* Quoted by High Plains

driving distance of the site

equipment delivery.

#### CALCULATIONS FOR REQUIRED AMOUNT OF PURCHASED CELLULASE LIQUICELL 2500

# ASED ON PUREVISION LABORATORY RESULTS OF COMPARISON

High Grade Waste Paper Substrate

Soluble Charbohydrate % degraded in 18 hrs.

Liquicell 2500 13%

87,059,020 ml/hr required for stover PureVision Cellulase 82% 13,057,632 ml/hr required for stover

effectiveness multiple 6.43

125	FPU/g protein	Liquicell 2500
731,295,772	liters/yr	Specialty
1.1000	S.G.	Enzymes
804,425,349	kg/yr	Inc.
193,062,084	gal/yr	
1,773,436,124	#/yr	
325,810	loads/yr	

cellulase storage tank

22,984 gal/hr

750,000 gal/vessel

33 vessel res. time (hr)

cellulase transfer pump

383 gpm

# ASED ON PRODUCT SPECIFICATIONS PROVIDED BY SPECIALTY ENZYMES INC.

32	FPU/ml	Liquicell 2500
48,566,337	liters/yr	Specialty
1.1000	S.G.	Enzymes
53,422,971	kg/yr	Inc.
12,821,513	gal/yr	
117,776,282	#/yr	
21,637	loads/yr	***

cellulase storage tank

14,021 gal/hr

750,000 gal/vessel

53 vessel res. time (hr)

cellulase transfer pump

234 gpm

# ansport Calculations

10,000 lbs/axel

9.19 cellulase lb/gal

5 axels/truck

5,443 gal/truck

50,000 lbs/truck

0.413 transport cost/lb